U.S. Fish and Wildlife Service
Office of Subsistence Management
Fisheries Resource Monitoring Program

Estimating Chinook salmon escapement on the Copper River, 2005 annual report

Annual Report for Study 04-503

The Native Village of Eyak
PO Box 1388
Cordova, AK 99574

LGL Alaska Research Associates, Inc.
1101 E. 76th Avenue, Suite B
Anchorage, AK 99518

March 2006

Estimating Chinook salmon escapement on the Copper River, 2005 annual report

Annual Report for Study 04-503

Jason J. Smith
LGL Alaska Research Associates, Inc.
1101 E. 76th Ave., Suite B
Anchorage, AK 99518

and

Keith M. van den Broek
Native Village of Eyak
P.O. Box 1388
Cordova, AK 99574

March 2006

ANNUAL REPORT SUMMARY PAGE

Title: Estimating Chinook salmon escapement on the Copper River.

Study Number: FIS 04-503

Investigators/Affiliations: Keith van den Broek and Bruce Cain, Native Village of Eyak; Jason J. Smith and Michael R. Link, LGL Alaska Research Associates, Inc.

Management Region: Cook Inlet/Gulf of Alaska (Southcentral)

Information types: Stock Status and Trends (SST)

Issues addressed: (1) Annual system-wide escapement estimates of Chinook salmon in the Copper River, (2) Build capacity of tribal organizations to conduct needed fisheries assessment.

Study cost: $964,235 (three-year total)

Study duration: January 2004 to March 2007

Key Words: Chinook salmon, fishwheels, mark-recapture, escapement estimates, subsistence fisheries, Baird Canyon, Copper River, Alaska, Native Village of Eyak

Citation: Smith, J. J. and van den Broek, K.M. 2005. Estimating Chinook salmon escapement on the Copper River, 2005 annual report. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program (Study No. 04-503), Anchorage, Alaska.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

LIST OF PHOTO PLATES

EXECUTIVE SUMMARY

The purpose of this project was to use fishwheels and two-sample mark-recapture methods for long-term monitoring of Chinook salmon *Oncorhynchus tshawytscha* escapement on the Copper River. This report summarizes results from the 2005 field season, the fifth year since the project's inception. Objectives for 2005 were to: (1) estimate the annual, system-wide escapement of Chinook salmon to the Copper River using mark-recapture methods, such that the estimate was within 25% of the actual escapement 95% of the time; (2) develop a long-term monitoring program operated by the Native Village of Eyak (NVE). For the first sample event, three live-capture fishwheels were operated at Baird Canyon for 3,257 h from 9 May to 15 July. During this period, 3,674 adult Chinook salmon were captured and 3,379 fish were marked. For the second sample event, two fishwheels were operated at Canyon Creek near the lower end of Wood Canyon for 3,658 h from 14 May to 7 August. A total of 3,158 Chinook salmon were captured and 3,150 fish were examined for marks, of which 315 were recaptures. Using a modified Peterson estimator, estimated abundance of Chinook salmon measuring 600 mm FL or greater that migrated upstream of Baird Canyon from 9 May to 14 July was 30,333 (SE = 1,529). Given an estimated inriver harvest of 10,000 Chinook salmon, the spawning escapement in 2005 was 20,333 fish, which was 15.3% lower than the escapement goal of 24,000 or more spawners. This was the first time since the project's inception that the escapement goal was not met. The median travel time of fish marked at Baird Canyon and recaptured at Canyon Creek (~91 km upstream) was 12 d. With funding currently approved through 2006, and a proposal being reviewed for funding through 2009, this project has evolved into a successful and potentially long-term monitoring program that has made NVE an integral part of Copper River salmon research.

Citation: Smith, J. J. and van den Broek, K. M. 2005. Estimating Chinook salmon escapement on the Copper River, 2005 annual report. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program (Study No. 04-503), Anchorage, Alaska.

INTRODUCTION

The Copper River supports one of the largest Chinook salmon *Oncorhynchus tshawytscha* subsistence fisheries in Alaska. The importance of Copper River Chinook salmon to subsistence and other users has focused attention on the paucity of information about escapement levels and distribution among tributaries. Despite the importance of this fishery, managers have found it difficult to obtain annual estimates of Chinook salmon escapement to the drainage. Many stakeholders believe that escapement indices generated by conventional methods (aerial surveys, sonar and weirs on selected systems) have not adequately assessed the abundance of Copper River Chinook salmon stocks.

From 1999-2004, the Alaska Department of Fish and Game (ADF&G) conducted radiotelemetry studies to derive the first system-wide estimates of Chinook salmon escapement to the Copper River (Evenson and Wuttig 2000; Wuttig and Evenson 2001; Savereide and Evenson 2002). Due to the project's high expense, biologists planned to terminate this telemetry-based, escapement-monitoring project after the 2001 season. The possible termination of the radio-tagging project created a need for the development of a long-term program to monitor Chinook salmon escapement in the Copper River.

The use of fishwheels (Meehan 1961; Donaldson and Cramer 1971) and mark-recapture techniques can often be an effective method for estimating Chinook salmon escapement. This technique has been used to generate system-wide salmon escapement estimates on numerous large rivers (Meehan 1961; Donaldson and Cramer 1971; Johnson et al. 1992; Arnason et al. 1996; Link et al. 1996; Cappiello and Bromaghin 1997; Gordon et al. 1998; Link and Nass 1999; Sturhahn and Nagtegaal 1999), and after four consecutive years of feasibility testing and full-scale operation, has proven extremely suitable for use on the Copper River (Link et al. 2001; Smith et al. 2003). The purpose of this study was to continue using fishwheels and two-sample mark-recapture methods for long-term monitoring of Chinook salmon *Oncorhynchus tshawytscha* escapement on the Copper River.

Objectives

The objectives for this three-year study were to:

(1) Estimate the annual, system-wide escapement of Chinook salmon to the Copper River using mark-recapture methods such that the estimate is within 25% of the actual escapement 95% of the time; and
(2) Develop a long-term monitoring program operated by the Native Village of Eyak (NVE).

In 2005, three tagging fishwheels were operated at Baird Canyon approximately 66 km (41 mi) upstream of where the Copper River enters the Gulf of Alaska. In addition, two recovery fishwheels were operated near Wood Canyon (river km, rkm 157) approximately 12 km downstream from Chitina, Alaska. This report documents the methods, results, and conclusions from the 2005 field season.

Study Area

The Copper River, which drains an area of more than 62,100 km^2 (24,000 mi^2), flows southward through south-central Alaska and enters the Gulf of Alaska near the town of Cordova (Fig. 1). Between the ocean and Miles Lake (rkm 48), the river channel traverses the Copper River Delta which is a large, highly braided, alluvial flood plain. A relatively high proportion of the Copper River's headwaters are glaciated (18% in 1995), resulting in very high unit discharge (volume per square kilometer of drainage area) and sediment loads (Brabets 1997). From 1988 to 1995, the annual mean discharge on the lower Copper River was 1,625 m^3/s (57,400 ft^3/s), with the majority of flow occurring during the summer months from snowmelt, rainfall and glacier melt (Brabets 1997). Peak discharge in June ranged from 3,650 to 4,235 m^3/s while annual peak discharge ranged from 6,681 to 11,750 m^3/s. Water levels in Baird Canyon typically rise sharply from late May through June, level off in July, and then peak in August. Sediment loads cause the water to be unusually turbid and fill the river with numerous ephemeral sandbars and channel braids for most of its length.

Two major channel constrictions in the lower Copper River between Miles Lake and the mouth of the Chitina River (rkm 172) offer the potential to capture substantial proportions of migrating Chinook salmon using fishwheels. Baird Canyon is the first major channel constriction on the Copper River upstream of Miles Lake that is suitable for operating the capture-tag fishwheels (Fig. 2). The east bank of Baird Canyon is a steep, often sheer, rock wall that rises over 600 m (1,970 ft) above the river. The west bank slopes more moderately to a maximum height of 20 m above the river, is densely wooded, and has a substrate ranging from sand to boulders. The land beyond the west bank is primarily a wetland area that drains the Allen Glacier to the west. The north branch of the Allen River enters on the west bank and is the only major tributary entering Baird Canyon.

Wood Canyon is the second major channel constriction on the Copper River upstream of Miles Lake and is located approximately 91 km upstream of Baird Canyon (Fig. 3). The lower end of Wood Canyon, below the mouth of Canyon Creek and the lower boundary of the Chitina Subdistrict dip net fishery, was considered a suitable location for operating the recapture fishwheels. The west bank in this area consists mostly of steep rock walls, whereas the east bank is a mix of sand bars, rock outcroppings, and rock walls.

Chinook and sockeye *O. nerka* salmon begin to enter the Copper River in early to mid-May, as rising temperatures and water flush the ice from the river. Nearly all Chinook and sockeye salmon enter the river by early August (Merritt and Roberson 1986; Evenson and Savereide 1999; Morstad et al. 1999; Evenson and Wuttig 2000; Sharp et al. 2000). The majority of the Chinook salmon run returns to six main tributaries in the upper Copper River, all of which are upstream of Baird and Wood canyons (Evenson and Savereide 1999; Evenson and Wuttig 2000). Since 1978, ADF&G has operated a sonar system to count salmon at the outlet of Miles Lake. An estimated 854,268 salmon passed the Miles Lake sonar site in 2005 (ADF&G 2006).

The Copper River supports important fisheries for Chinook salmon. The current 10-year average for Copper River Chinook salmon harvest is 49,919 (ADF&G 2006). The majority of Chinook salmon are caught in an ocean commercial gill net fishery that operates from mid-May to the end of July in the Copper River District near the mouth of the Copper River. Inriver personal use and subsistence fisheries occur from early June through September between Haley Creek and the confluence of the Slana River on the upper Copper River. Rod-and-reel sport fisheries target Chinook salmon in tributaries of the upper Copper River (primarily Gulkana, Klutina, and Tonsina rivers). The 2005 harvest of Chinook salmon in the Copper River District commercial fishery was 34,624 fish, and the harvest for the combined inriver fisheries was estimated at 10,000 fish (ADF&G 2006).

METHODS

Project Mobilization

Hiring and Training

Preferred skills of potential candidates for the fisheries technician positions included: prior experience or formal education in either fisheries science or management, experience in salmon fisheries, experience working in a remote field camp, watercraft operation and maintenance or other technical skills, experience working with Alaska Native Tribes and computer skills or record-keeping abilities. Staff from NVE conducted interviews and screened all the applicants. Severn full-time technicians were hired, including three returning technicians from 2004 and one returning from 2003. Several other technicians were hired temporarily throughout the season during peak sampling periods, mobilization, and de-mobilization. Preseason training consisted of an overview of the project and NVE policies, first aid/CPR certification, and shotgun maintenance and safety training including bear safety videos. Inseason training focused on fishwheel operation, maintenance and safety, boat operation and maintenance, fish sampling, data recording, and basic computer skills.

Permit Requirements

In order to access and operate both field camps and install the fishwheels on the Copper River (including anchoring them to the shore), land-use permits were obtained from the U.S. Forest Service (USFS), Alaska Department of Natural Resources (Division of Mining, Land, and Water), Chugach Alaska Corporation, Eyak Corporation, and Ahtna Incorporated. Permits were also acquired from ADF&G for fish collection and sampling. All permits were obtained prior to the start of the field season.

Fishwheel Design and Construction

Three tagging fishwheels (fishwheels 1, 2, and 3) operated at Baird Canyon, and two recovery fishwheels (fishwheels 3 and 4) at Canyon Creek in 2005. Two of the fishwheels at Baird Canyon (fishwheels 1 and 2) and 1 fishwheel at Canyon Creek (fishwheel 3) were large aluminum models intended for fishing against deep canyon walls. These were made of two, welded aluminum pontoons (11.6 m long x 0.9 m wide x 0.5 m deep), a 3.7 m long axle, three baskets (3.0 x 3.0 m x 2.1 m), and a tower (6.1 m high) and boom (4.9 m long) assembly that was used to raise and lower the axle. The baskets were designed to fish up to about 3 m below the water surface and were lined with knotless nylon mesh (6.4 cm stretch). The baskets on fishwheel 3 were cut shorter than those on fishwheels 1 and 2 to allow shallower fishing depths. An aluminum tank (4.3 m long x 1.5 m deep x 0.6 m wide) for holding captured fish was fitted inside each pontoon. The bottom of each live tank was fitted with windows of extruded aluminum mesh to allow for ample water circulation, and an escape panel fitted to the stern of each tank to prevent overcrowding of smaller sockeye salmon and undersized king salmon.

The third fishwheel at Baird Canyon was new in 2005, and similar in design to fishwheel 4 that operated at Canyon Creek. Both of these fishwheels were fabricated with assistance from Tazlina Elder Johnny Goodlataw (Photo 1). These fishwheels were composed of two aluminum pontoons (11.6 m long x 0.6 m wide x 0.5 m deep), four lumber and spruce pole baskets (2 m long x 1.8 m wide x 0.8 m deep), and a tower assembly designed to raise and lower the axle. The baskets were lined with knotless nylon mesh (6.4 cm stretch). As with the other fishwheels, each live tank was fitted with windows of extruded aluminum mesh and an escape panel.

Mobilizing the Field Camps

At Baird Canyon, a cabin that NVE built in the fall of 2001 served as the field camp in 2005. The cabin is located on the west bank of the Copper River approximately 2 km upstream from the upper end of Baird Canyon (Fig. 2), and was supplied by boat or plane from Cordova. The Canyon Creek camp was located on the east bank of the Copper River approximately 12 km downstream from Chitina, which was the same location used during the 2003 season (Fig. 3). The upriver camp consisted of two Weatherport tents and small sleeping tents for crew members and it was supplied mainly by boat from Chitina. Mobilization at both camps was timed to ensure that the fishwheels were operational as soon as the river ice cleared and the first Chinook salmon began migrating past each location.

Camp Communication

The field crews followed a specific communication protocol to ensure that the camps were operated as safely and efficiently as possible. Each camp was equipped with a base-station VHF and several handheld VHF radios, "Iridium" satellite telephones, and a "Starband" satellite internet system (McLean, VA) that provided continuous high-speed internet access. These systems were powered/charged by an array of 6-V batteries (wired to provide 12-V power) that were charged by solar panels and a gas-powered generator. Every morning at a prearranged time, one crew member from each camp was responsible for contacting the NVE office in Cordova via email to exchange information (e.g., provide daily fishwheel catches, place food and supply orders, arrange flights and crew changes). A majority of camp communications were conducted via the internet, with satellite phones reserved for emergencies and instances where internet was temporarily unavailable. The crew was able to communicate camp needs in a timely and cost-effective manner, receive feedback on project operations from senior managers, and provide daily catch and tag updates to ADF&G biologists and fishery managers.

Fishwheel Operation and Catch

Fishwheel Operation

Suitable fishwheel sites were selected based on water depth, water velocity, accessibility, bankfull width, and protection from floating debris and rock fall. For the two large fishwheels used on this project, water depths greater than 3 m and velocities ranging from 0.5-1.5 m/s (1.6-4.9 ft/s) were needed to rotate the baskets at optimal speeds and force migrating fish to travel near shore and into the path of the fishwheels. Narrow, fast-flowing channels tend to concentrate migrating salmon close to shore and are thus preferred to wide, slow-flowing areas. The small, four-basket fishwheels could operate in slower water velocities and shallower depths than the large fishwheels. The basket assembly of fishwheels 4 and 5 could also be raised or lowered as water levels changed throughout the season.

The three large fishwheels used in 2004 were installed and operated similar to the methods used in previous years (Link et al. 2001; Smith et al. 2003; Smith 2004; Smith et al. 2005; Smith and van den Broek 2005). A rock drill was used to set steel anchor pins into the rock walls at the Baird Canyon and Canyon Creek fishwheel sites. Anchor lines attached to these pins consisted of galvanized wire rope (1.3 cm dia) and polypropylene rope (1.9 cm dia). To hold the fishwheels in place when fishing against gravel banks, a boat anchor was buried 1.5 m deep on the river bank approximately 30 m upstream of the fishing site. Wire rope (1.3 cm dia) was then attached to the fishwheel at one end and to the anchor at the other end. Two, propeller-driven, outboard motors were mounted on transoms at the stern of the fishwheel pontoons and were used to move the fishwheels between sites. Fishwheels were re-positioned upriver and downriver by adjusting the bow anchor lines, and laterally by adjusting the stern and side anchor lines.

The fishwheels were operated 24 hours per day, except for stoppages when they were being re-positioned or repaired. Fishwheel speed (revolutions per minute, rpm) was determined one or more times each day by measuring the time required for the fishwheel baskets to complete three revolutions, thus mitigating for the effects of temporary surges in water velocity. If fishwheel speed was recorded more than once in a day, the arithmetic mean of the measurements was calculated. Daily water levels (m) at both camps were measured from an aluminum staff gauge that was secured to the canyon wall near the fishwheels.

Fishwheel Catch and Effort

Two forms of fishwheel effort were calculated. First, *daily fishing effort* was computed as the number of hours that a fishwheel operated on a given calendar day from midnight to midnight. Second, *effort for calculating catch per unit effort (CPUE)* was computed as the number of hours that a fishwheel fished to obtain a given day's catch. These two effort values were often not the same for a given day because the live tanks were not always emptied of fish at the exact same times each evening. For example, if fish were last sampled at 2200 hours on day t and last sampled on day t+1 at 2000 hours, then only 22 hours of fishing effort was used to obtain the *effort for calculating CPUE* on day t+1 (assuming uninterrupted fishwheel operation). However, in this example, the *daily fishing effort* on day t+1 would be 24 hours because the fishwheel operated continuously for the entire calendar day. *Effort for calculating CPUE* on day t+1 could also exceed 24 hours if the last sampling session on day t was earlier in the day than the last sampling session on day *t*+1. To calculate CPUE (fish per fishwheel hour), the total number of fish captured on a given calendar day was divided by that day's effort for CPUE.

In order to reduce the potential for high densities and crowding of fish in the live tanks, escape panels were installed in the live tanks of all project fishwheels (see Photo 6 on p. 84 in Smith et al. 2003). The escape panels consisted of two, adjustable vertical slots in a removable aluminum frame. When installed and opened to the appropriate width (6 to 7.5 cm), the escape panels allow smaller fish (e.g., sockeye and other by-catch species) to easily swim out of the live tanks while retaining Chinook salmon. As a result, the escape panels reduce crowding and the potential for sampling mortalities during high-catch periods as well as the amount of crew labor for handling fish. Tests in 2004 indicated that the escape panels allowed 69-100% of sockeye salmon to escape from the live tanks, while retaining 100% of the adult Chinook salmon captured (Smith 2004). The escape panels on the Baird Canyon fishwheels were closed intermittently on pre-arranged intervals to allow retention of sockeye salmon for a radiotelemetry study (FIS05-501); however, this did not interfere with the capture or sampling of Chinook salmon for this study.

Tag Application and Recovery

Two to four times per day, depending on catches, crews at Baird Canyon and Canyon Creek removed all fish in the live tanks of each fishwheel. All adult Chinook salmon were counted, sexed, measured for length, inspected for an adipose fin (a missing adipose fin indicated a coded-wire-tagged, or CWT hatchery fish) and examined for marks, scars or bleeding. Fork lengths, measured from the tip of the nose to the fork of the tail, were collected in 2004. Chinook salmon were transferred with a dip net from the live tanks to a V-shaped, water-filled, foam-lined trough (with a fixed measuring tape) for sampling. Water in the trough was changed repeatedly throughout each sampling session. All other captured fish were identified to species, counted, and released.

At Baird Canyon, Chinook salmon greater than 600 mm FL and in good condition were marked with a uniquely coded yellow spaghetti tag (Floy Tag and Manufacturing Co., Inc., Seattle, WA) and right operculum punch. The tags were constructed of a 5-cm section of Floy tubing shrunk onto a 38-cm piece of 80-lb monofilament fishing line. Using a 10-cm hypodermic needle (16 gauge), the monofilament was sewn through the musculature of the fish 1-2 cm ventral to the insertion of the dorsal fin between the third and fourth fin rays from the posterior of the dorsal fin. The tag was secured by crimping (1.3 mm crimps) the monofilament line.

In addition to the general sampling procedures described above (i.e., counting, recording length and sex, and examining for adipose fin and physical marks), all Chinook salmon caught at the Canyon Creek fishwheels were examined for a spaghetti tag and right operculum punch. If a fish was marked, the spaghetti-tag number was recorded. Prior to release, all unmarked fish received a left operculum punch in order to identify them as previously caught at the Canyon Creek fishwheels.

Inriver Abundance Estimate

Conditions for a Consistent Abundance Estimate

Two-sample mark-recapture methods were used to estimate the inriver abundance of adult Chinook salmon above the Baird Canyon fishwheels. These abundance estimates are potentially biased if any of the assumptions inherent to the mark-recapture model are violated (Ricker 1975; Seber 1982). The following assumptions are relevant to this study and are similar to those examined by ADF&G in recent Chinook salmon radiotelemetry studies on the Copper River (Evenson and Wuttig 2000; Wuttig and Evenson 2001; Savereide and Evenson 2002; Savereide 2003).

Handling and tagging fish did not make them more or less vulnerable to recapture than untagged fish.

There was no explicit test for this assumption because the behavior of untagged fish could not be assessed. Sampling sessions were frequent (minimum of three times per day) to ensure that fish were not retained in the live tanks for long periods of time. Escape panels were used to reduce fish densities in the live tanks, particularly during periods of high sockeye catches. Technicians were trained by experienced biologists on how to handle and sample fish in order to reduce the amount of stress on the fish. Visibly stressed or injured fish were not tagged. Also, the distance between the tag and recapture sites (91 km) was assumed sufficient enough to reduce the potential of handling-induced "trap shyness" in tagged fish.

Tagged fish did not lose their tags, and there was no mortality of tagged fish between the tagging and recovery sites.

Only Chinook salmon that received both a primary and secondary mark at Baird Canyon were included in the calculations of abundance, so the chance of a fish losing both marks between sampling events was assumed to be negligible. Similarly, only fish that were examined for both marks at Canyon Creek were included in the analysis.

Tagged fish mixed completely with untagged fish between the sampling events.

The Copper River is highly braided in some sections between Baird Canyon and Canyon Creek which reduced the chances that tagged and untagged fish remain unmixed between sample events. Results from previous years of this study have shown that recapture rates for fish tagged at Baird Canyon and recaptured at Canyon Creek were independent of the bank of capture (Smith et al. 2003). Furthermore, studies from 1999-2001 showed equal mixing of tagged and untagged Chinook salmon between the lower end of Wood Canyon and the CSS fishery (Evenson and Wuttig 2000; Wuttig and Evenson 2001; Savereide and Evenson 2002), a much shorter distance and more coherent channel than between the Baird Canyon and Canyon Creek fishwheels.

Fish had equal probabilities of being marked or equal probabilities of being recaptured regardless of size.

To test for size-selective sampling at the fishwheels, Kolmogorov-Smirnov (K-S) two-sample tests (Zar 1984) were used to compare the cumulative length-frequency distributions of: (1) all fish tagged during the first sampling event and all fish recaptured during the second event; and (2) all fish tagged during the first sampling event and all fish examined during the second event (as presented in Bernard and Hansen 1992).

Fish had equal probabilities of being marked regardless of time of capture.

Apart from minor fishwheel stoppages for repairs and moves, fishing effort at the Baird Canyon fishwheels was continuous throughout the study period. Weekly mark rates in the second event were compared using contingency table analysis to determine whether this condition was met.

Marked fish had equal probabilities of being recaptured regardless of when they passed the recapture fishwheel.

Weekly recapture rates in the second event were compared using contingency table analysis. If both the mark rates and recapture rates varied among weeks, and a sufficient number of recaptures were available, a temporally stratified estimator would be used.

Abundance Estimate

A modified Peterson estimator was used to estimate abundance above Baird Canyon. The computer program SPAS (Arnason et al. 1996) was used to calculate the abundance estimate and standard error.

RESULTS

Project Mobilization

Mobilization of the Baird Canyon camp began on 6 May (Photo 2). Two people were flown in at that time to begin assembling fishwheel baskets and removing snow from the pontoon assemblies. Snow cover was less than 1 m deep upon arrival. The remaining technicians were flown to camp on 8 May to complete preparations and launch the fishwheels. The first fishwheel began fishing at Baird Canyon on 9 May. Fishwheel 5 was transported from Cordova to the Million Dollar Bridge in April. An excavator was used to pull the entire fishwheel assembly across the snow from the Million Dollar Bridge to the mouth of the south arm of the Allen River. Due to a dramatic decrease in water levels, fishwheel 5 could not be moved from the Allen River drop-site upriver to Baird Canyon until June.

Mobilization of the Canyon Creek fishwheels began on 12 May. Equipment and vehicles were moved from storage locations in Cordova, Glennallen, and Gakona to the camp site using trucks and jet boats. The fishwheels required only minor repairs and the first one began fishing on 14

May. New fishing sites had to be assessed because shifting channels and accumulation of debris made the sites used in previous years unsuitable. The fishwheels were moved several times before the final sampling sites were chosen.

Fishwheel Operation and Catch

Fishwheel Operation

Copper River stage height at Baird Canyon varied by 4.8 m from 11 May to 3 August (Fig. 4). At Canyon Creek, water levels varied by 3.0 m from 17 May to 7 August (Fig. 4). Water levels increased gradually from 11 May to 10 June, and increased dramatically from 11 June to 20 June. Apart from three days in late June, the stage height of the Copper River at the Million Dollar Bridge exceeded the 1982 to 2004 average from 15 May through 17 July, a period which covered the majority of the time that the fishwheels were fishing (Fig. 5). On 14 July, the Copper River stage height exceeded the maximum recorded height since 1982.

Fishwheel 1 operated on the east bank of Baird Canyon for a total of 1,296 h (90.5% of the time) from 1445 hours on 16 May to 0726 hours on 15 July (Fig. 6; Appendix A.1). Fishwheel 2 operated on the west bank of Baird Canyon for 923 h (99.5% of the time) from 1620 hours on 9 May to 0800 hours on 17 June. Fishwheel 5 operated at two sites in 2005. From 1230 hours on 20 June to 1800 hours on 20 July, fishwheel 5 operated on the west bank of the Copper River approximately 1.5 km upstream from Baird Canyon (Photo 3). On 20 July, it was moved to a new site located approximately 500 m downstream of the first site. Fishwheel 5 operated for a total of 1,039 h (98.7% of the time) and it was stopped for the season at 0910 hours on 3 August. Fishwheel speeds averaged 2.2, 2.7, and 2.9 rpm for fishwheels 1, 2, and 5, respectively (Fig. 6; Appendix A.1).

Fishwheel 3 at Canyon Creek operated at four different sites in 2005. From 0930 hours on 19 May to 1300 hours on 27 May, it operated at two sites located along the west bank of the Copper River between 2.0 and 2.4 km downstream from the mouth of Canyon Creek. Fishwheel 3 operated from 1500 hours on 27 May to 1530 hours on 6 June at an east-bank site located 1.5 km downstream of the Canyon Creek camp. And lastly, from 1530 hours on 6 June to 0910 hours on 3 August, fishwheel 3 operated at an east bank site located 2.7 km downstream from the mouth of Canyon Creek and 300 m upstream of the camp (Photo 4). In total, fishwheel 3 operated for 1,852 h (96.5 % of the time; Fig. 6; Appendix A.1).

Due to changes in channel dynamics and the accumulation of debris following the high water events in 2004, the site used for fishwheel 4 in 2004 was no longer suitable. Three alternative sites for fishwheel 4 were used in 2005. From 1730 hours on 14 May to 1630 hours on 20 May, fishwheel 4 operated on the west bank of the Copper River approximately 500 m downstream from the mouth of Canyon Creek. On 20 May, fishwheel 4 was moved to a new site on the east bank approximately 2 km downstream of Canyon Creek (Photo 4). On 19 June, fishwheel 4 was moved downstream to a site located at the field camp where it operated until 0700 hours on 31 July. In total, fishwheel 4 operated for 1,807 h or 98.3% of the time it was in place. Fishwheel speeds averaged 2.6 and 4.4 rpm for fishwheels 3 and 4, respectively (Fig. 6; Appendix A.1).

Fishwheel Catch

A total of 3,674 adult Chinook salmon were captured at the Baird Canyon fishwheels (Fig. 7; Appendix A.2). Fishwheel 1 captured 1,357 Chinook salmon from 16 May to 15 July, fishwheel 2 captured 2,294 Chinook salmon from 9 May to 17 June, and fishwheel 5 captured 23 Chinook salmon from 21 June to 11 July. Total daily catch peaked at 168 Chinook salmon on 2 June. Daily CPUE peaked at 3.7, 5.2, and 0.2 fish per hour for fishwheels 1, 2, and 5, respectively (Fig. 8; Appendix A.2). There were also 4,378 adult sockeye salmon, 1 whitefish *Coregonus nelsoni*, 1 Pacific lamprey *Lampetra tridentata*, 1 sucker *Catostomus sp.*, and 1 salmon smolt *Oncorhynchus sp*. captured at the Baird Canyon fishwheels.

A total of 3,158 Chinook salmon were captured at the Canyon Creek fishwheels (Fig. 7; Appendix A.2). Fishwheel 3 captured 722 Chinook salmon from 19 May to 7 August and Fishwheel 4 captured 2,436 Chinook salmon from 15 May to 29 July. Daily catch peaked at 114 Chinook salmon on 7 June. Daily CPUE peaked at 2.4 and 4.3 fish per hour at fishwheels 3 and 4, respectively (Fig. 7; Appendix A.2). The number of adult sockeye salmon captured at the Canyon Creek fishwheels was not accurately recorded in 2005; however, 1 Pacific lamprey and 4 whitefish *Coregonus nelsoni* were reported captured.

Tag Application and Recovery

Of the 3,674 Chinook salmon captured at the Baird Canyon fishwheels, 3,379 fish (92.0%) were tagged with a spaghetti tag and released (Fig. 9; Table 1; Appendix A.3). The number of marks applied on a single day peaked at 159 fish on 27 May. The remaining 295 fish (8.0%) were not tagged because they escaped prior to being sampled (147 fish), were visibly injured or stressed (137 fish), mortalities (6 fish), coded-wire-tagged (3 fish), or less than 500 mm FL (2 fish; Table 1).

Of the 3,158 Chinook salmon captured at the Canyon Creek fishwheels, 3,150 fish (99.7%) were examined for a primary and secondary mark (Fig. 9; Table 2; Appendix A.3). Of those examined, 315 (10.0%) were recaptures, or fish that were marked at the Baird Canyon fishwheels. The first marked fish was captured at Canyon Creek on 16 May (tagged on 10 May), while the last marked fish was captured on 24 July (tagged on 9 July). The number of fish examined for marks at Canyon Creek peaked at 114 fish on 7 June and the number of recaptures peaked at 17 fish on 4 June and 8 June. Eight fish (0.3%) escaped before being examined for marks (Table 2).

The median travel time of Chinook salmon tagged at Baird Canyon and recaptured at Canyon Creek was 12 d (mean = 13.5 d, range = 2-39 d, n = 315, Fig. 10).

Inriver Abundance Estimate

Conditions for a Consistent Estimator

The probability of capture for fish at Canyon Creek appeared to be unaffected by the handling and tagging procedures at Baird Canyon. The tag number of marked fish released and later recaptured at the Baird Canyon fishwheels was recorded and used to calculate migratory delay.

Of the 212 fish captured twice, 72 fish (34%) were recaptured with 1 d of being tagged, and the longest delay between captures was 39 d (Figure 11). We assumed that these migratory delays had no affect on the abundance estimate. Tag loss and natural mortality were assumed to be negligible between the sampling events. No fish were captured at Canyon Creek with an operculum punch and no spaghetti tag, so it was assumed that no fish shed their primary mark.

Tagged fish appeared to move equally between banks. The recapture rate of fish tagged and released on the west bank of the river was not significantly different than the recapture rate of fish tagged on the east bank ($\chi^2 = 2.6$, df = 1, P = 0.11; Table 3). Cumulative length-frequency distributions of fish marked in the first event and fish recaptured in the second event were not significantly different ($D_{max} = 0.11$, P = 0.12, Fig. 12). In contrast, the cumulative length-frequency distributions of fish marked in the first event and fish examined for marks in the second event were significantly different ($D_{max} = 0.11$, P = 0.00). Thus, there was no size selectivity during the second event but there was during the first event, and no stratification by size was necessary to estimate abundance.

Capture statistics were summarized by week of marking and week of recapture over the study period (Table 3). The probability of a fish being marked at Baird Canyon was not independent of time of capture. Mark rates were significantly different ($\chi^2 = 28$, df = 8, P = 0.00) and varied from 0.02 to 0.13. However, recapture rates were not significantly different over the study period ($\chi^2 = 11$, df = 7, P = 0.16) and varied from 0.05 to 0.11. Based on these tests, the data did not need to be stratified by time and a pooled Petersen estimator could be used to estimate abundance.

Abundance Estimate

Using a modified Petersen estimator, estimated abundance of Chinook salmon measuring 600 mm FL or greater that migrated upstream of Baird Canyon from 9 May to 14 July was 30,333 (SE = 1,529). This estimate was based on 3,379 tagged fish available for recapture, 3,150 fish examined for tags, and 315 recaptures.

DISCUSSION

Project Mobilization

In 2005, the Baird Canyon fishwheels began operating earlier than in previous years due to relatively light snow loads and early break up of river ice. Mobilization at Baird Canyon took approximately 9 d and the first fishwheel began fishing on 9 May. This was considerably shorter than it took to mobilize Baird Canyon in 2004 when heavy snow cover slowed mobilization efforts. Successful mobilization in 2005 was attributed to several factors, including:

(1) Efficient organization and equipment storage during demobilization in 2004. The fishwheel pontoon assemblies were lined up near the river bank, all fishwheel baskets were disassembled to prevent damage over the winter, and all supplies were consolidated and stored inside the fishwheel live tanks or cabin (Photo 2);

(2) All required materials were ordered in advance and available during mobilization;
(3) There was no significant damage to any equipment over the winter;
(4) An experienced crew was used during mobilization which expedited fishwheel assembly and reduced the amount of crew training required;
(5) The availability of a cabin stocked with the majority of supplies needed for mobilization; and
(6) The sites for fishwheels 1 and 2 had been used in previous study years and thus required little effort to prepare in May 2005.

The Canyon Creek fishwheels were stored intact at the camp site and there was no need for major repairs or modification prior to sampling. There was no on-site storage at the Canyon Creek camp like there was at Baird Canyon, but all equipment was successfully moved from storage facilities in Cordova, Glennallen, and Gakona to the Canyon Creek camp in less than 2 d. The timing and execution of mobilization at both camps was suitable given the environmental conditions in early May.

Fishwheel Operation and Catch

Catches of Chinook salmon at the Baird Canyon fishwheels have increased each year since the projects inception. These increases are attributable to increases in fishing effort, experience with existing fishwheel sites, and the ability to effectively operate fishwheels during a wide range of water levels. Catches of Chinook salmon were 33% greater in 2005 (3,674 fish) than catches in 2004 (2,756 fish). The significant increase in catch in 2005 was primarily due to ideal climatic and water-level conditions throughout most of the run. The addition of fishwheel 5 in 2005 did not contribute greatly to the catch of Chinook salmon (23 fish).

At Canyon Creek, Chinook salmon catches in 2005 (3,158 fish) were 5% lower than catches in 2004 (3,339). This was the first year since 2003 that Chinook salmon catches decreased relative to the previous year. Interestingly, two fishwheels (fishwheels 3 and 4) were operated in 2005 whereas only one fishwheel (fishwheel 4) was used in 2004. The decrease in catch in 2005 was largely attributed to the loss of an extremely effective site located along a gravel bar on the west bank of the river. This site was used in 2003 and 2004, but it was not suitable in 2005 because of changes in channel morphology that occurred after the 2004 fishing season. New sites were located for both fishwheels 3 and 4 in 2005, but catch rates were not as high as at the old sites. The smaller, subsistence-style fishwheel (2,436 fish) at Canyon Creek was more effective at capturing Chinook salmon than the larger fishwheel (722 fish).

Abundance Estimate

A continuing challenge of this project is to catch sufficient numbers of Chinook salmon during each sampling event from an expected population of 40,000 fish that migrated over a two-month period through widely fluctuating water conditions. In 2005, the number of Chinook salmon marked at Baird Canyon (3,379 fish) and examined for marks at Canyon Creek (3,150 fish) exceeded the target levels. More importantly, the number of tagged fish recaptured at Canyon Creek (315 fish) was sufficient to develop an unbiased and very precise abundance estimate (coefficient of variation measured at 5% of the estimate). The escapement goal set by the Board of Fisheries for Chinook salmon on the Copper River is 24,000 or more spawners. With an estimated inriver harvest of 10,000 Chinook salmon, and an abundance estimate of 30,333 fish past Baird Canyon, the spawning escapement in 2005 was 20,333 Chinook salmon, or 15.3% lower than the escapement goal. This was the first time since the project's inception that the escapement goal was not met (Table 5).

CONCLUSIONS

This year (2005) was the second of three years in the current funding cycle to operate a long-term Chinook salmon escapement monitoring project on the Copper River. Despite the numerous and often significant challenges encountered during this study, it has continued to meet or exceed all project objectives and expectations. Drainage-wide abundance estimates have been generated consistently and reliably for four years, and the project has evolved into a long-term monitoring program that has made NVE an integral part of Copper River salmon research. In addition, this project has demonstrated that several agencies (e.g., USFWS, NVE, ADF&G) can work cooperatively to collect valuable data on Copper River salmon stocks that will be used to assess current management practices. Given the success of the project, it appears that fishwheels and mark-recapture methods can be used to estimate the inriver abundance of Chinook salmon on the Copper River well into the future.

The project has also demonstrated that Federal, State, and Tribal agencies can work cooperatively to collect data on Copper River salmon stocks that are used to assess, and potentially improve, current management practices. This was shown at the 2005 Board of Fisheries meetings, where ADF&G managers relied on the data collected on this project to make several management decisions which will impact the fishery in 2006.

RECOMMENDATIONS

In light of the preceding discussion and the fact this project will be funded by the Federal Subsistence Board for at least another year, the following are recommended for the 2006 field season:

(1) Continue to follow and refine the demobilization procedures that have been developed since the project's inception;
(2) Mobilize half of the Baird Canyon crew around 5 May and the other half on 9 May; and mobilize the Canyon Creek crew around 12 May;
(3) Operate one fishwheel at Site 2 and one fishwheel at Site 3 at Baird Canyon; and continue to assess more suitable sites for fishwheel 5;
(4) Continue to operate fishwheels 3 and 4 at the upstream end of the campsite islands during low- to mid- level waters, moving Fishwheel 4 to the bank in front of camp during high-water events;
(5) Continue to use the escape panels in each fishwheel with the openings set to a width of 6.5 cm, except when closed for sockeye salmon sampling requirements.

(6) If water level is rising quickly and is expected to continue rising, move fishwheel 1 and fishwheel 2 to protected sites closer to the Baird Canyon cabin before water level reaches a critical height. Continue site assessment to find a more suitable site to operate these fishwheels during high water events.
(7) Consider the possibility of constructing a storage shed adjacent to the Baird Canyon cabin which can accommodate fully assembled baskets from all fishwheels, allowing far more efficient mobilization each spring.
(8) Replace old and faulty equipment, especially supply and logistics boats "Lawrence" and "Loophole," and camp boats "Sockeye" and "Coho." Demote the SeaArk boats at each camp to safety backup boats once new boats are in place.

ACKNOWLEDGMENTS

Technicians were hired locally by NVE to assist with fishwheel construction, transportation, installation, operation, inseason maintenance, fish sampling, and data collection. Full-time, full season technicians included Guy Wade (LGL), Gerald Stevens, Graham Predeger, Jake Fergeson, Joe Graves, Eric Stevens, Aaron Cole, and Zach Pickett. Lawrence Stephens assisted with mobilization, fishwheel assembly, and early sampling. Jeremy Sofonia, Ed Vlasoff, Crystal DeVille, Kaila Hawley, and Thomasina Anderson provided assistance as temporary technicians when required. Bruce Cain and Erica McCall Valentine (NVE) assisted with project logistics and reviewed drafts of this report. Justin Burket and Jeremy Sofonia helped set up Starband, communication, computer and electrical systems. Michael Link (LGL) was a principal investigator and his contributions were instrumental to the success of this study. James Savereide (ADF&G, Division of Sport Fish, Fairbanks) assisted with fishwheel installation and maintenance, sampling and data collection. Steve Moffitt (ADF&G, Commercial Fisheries Division, Cordova) provided valuable inseason fishery information. Johnny Goodlataw and Vincent Goodlataw (Tazlina) were contracted to rebuilt Fishwheel 4 baskets and construct new baskets for Fishwheel 5; Lenny Peterson (Peterson Welding and Machine, Cordova) modified herring pound pontoons for Fishwheel 5, and assisted with small repairs throughout the season. Air support was provided by Cordova Air.

This project (FIS04-503) was approved by the Federal Subsistence Board, managed by the U.S. Fish and Wildlife Service, Office of Subsistence Management, and funded by the USFS. This project was a cooperative effort between the USFS, NVE, LGL, and ADF&G, and this annual report partially fulfills contract obligations for USFS Contract #53-0109-2-00591.

LITERATURE CITED

ADF&G. 2006. Commercial fisheries news release, 2005 season summary. Retrieved on 13 March 2006 from the Alaska Department of Fish and Game, Division of Commercial Fisheries webpage: http://www.cf.adfg.state.ak.us/region2/pwshome.php.

Arnason, A. N., C. W. Kirby, C. J. Schwarz, and J. R. Irvine. 1996. Computer analysis of data from stratified mark-recovery experiments for estimation of salmon escapements and other populations. Can. Tech. Rep. Fish. Aquat. Sci. 2106: vi + 37.

Bernard, D., and P. A. Hansen. 1992. Mark-recapture experiments to estimate the abundance of fish. Alaska Department of Fish and Game, Division of Sport Fish, Special Publication No. 92-4, Anchorage.

Brabets, T. P. 1997. Geomorphology of the lower Copper River, Alaska. United States Geological Survey, U.S. Geological Survey Professional Paper 1581, Denver.

Cappiello, T. A., and J. F. Bromaghin. 1997. Mark-recapture abundance estimates of fall-run chum salmon in the Upper Tanana River, Alaska, 1995. Alaska Fishery Research Bulletin 4(1): 12-35.

Donaldson, I. J., and F. K. Cramer. 1971. Fishwheels of the Columbia. Binfords and Mort Publishers, Portland. 124 p.

Evenson, M. J., and J. W. Savereide. 1999. A historical summary of harvest, age composition, and escapement data for Copper River Chinook salmon, 1969-1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-27, Anchorage.

Evenson, M. J., and K. G. Wuttig. 2000. Inriver abundance, spawning distribution, and migratory timing of Copper River Chinook salmon in 1999. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 00-32, Anchorage.

Gordon, J. A., S. P. Klosiewski, T. J. Underwood, and R. J. Brown. 1998. Estimated abundance of adult fall chum salmon in the Upper Yukon River, Alaska, 1996. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 45, Fairbanks.

Johnson, R. E., R. P. Marshall, and S. T. Elliot. 1992. Chilkat River chinook salmon studies, 1991. Alaska Department of Fish and Game, Division of Sport Fish, Fishery Data Series No. 92-49, Anchorage, AK.

Link, M. R., K. K. English, and R. C. Bocking. 1996. The 1992 fishwheel project on the Nass River and an evaluation of fishwheels as an inseason management and stock assessment tool for the Nass River. Can. Manuscr. Rep. Fish. Aquat. Sci. 2372: x + 82.

Link, M. R., and B. L. Nass. 1999. Estimated abundance of Chinook salmon returning to the Nass River, B.C., 1997. Can. Manuscr. Rep. Fish. Aquat. Sci. 2475: xi + 64.

Link, M. R., M. J. Nemeth, and R. Henrichs. 2001. Feasibility of using fishwheels for long-term monitoring of Chinook salmon escapement on the Copper River. U.S. Fish and Wildlife Service, Office of Subsistence Management, Anchorage.

Meehan, W. R. 1961. The use of a fishwheel in salmon research and management. Transactions of the American Fisheries Society 90: 490-494.

Merritt, M. F., and K. Roberson. 1986. Migratory timing of upper Copper River sockeye salmon stocks and its implications for the regulation of the commercial fishery. N. Amer. J. Fish. Manag. 6: 216-225.

Morstad, S., D. Sharp, J. Wilcock, T. Joyce, and J. Johnson. 1999. Prince William Sound management area 1998 annual finfish management report. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 2A99-20, Anchorage.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish. Res. Board Can. 191. 382 p.

Savereide, J. W. 2003. Inriver abundance, spawning distribution, and run timing of Copper River Chinook salmon in 2002. Alaska Department of Fish and Game, Fisheries Data Series No. 03-21, Anchorage.

Savereide, J. W., and M. J. Evenson. 2002. Inriver abundance, spawning distribution, and migratory timing of Copper River Chinook salmon in 2001. Alaska Department of Fish and Game, Fishery Data Series No. 02-28, Anchorage.

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, 2nd edition. Charles Griffin and Company, Ltd., London. 654 p.

Sharp, D., T. Joyce, J. Johnson, S. Moffitt, and M. Willette. 2000. Prince William Sound management area: 1999 annual finfish management report. Alaska Department of Fish and Game, Commercial Fisheries Division, Regional Information Report No. 2A00-32, Anchorage, AK.

Smith, J. J. 2004. Feasibility of using fishwheels for long-term monitoring of Chinook salmon escapement on the Copper River, 2003 annual report. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program (Study No. 01-020), Anchorage, Alaska.

Smith, J. J., M. R. Link, and B. D. Cain. 2005. Development of a long-term monitoring project to estimate abundance of Chinook salmon in the Copper River, Alaska, 2001-2004. Alaska Fishery Research Bulletin 11(2): 118-134.

Smith, J. J., M. R. Link, and M. B. Lambert. 2003. Feasibility of using fishwheels for long-term monitoring of Chinook salmon escapement on the Copper River, 2002 annual report. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program (Study No. 01-020), Anchorage, Alaska.

Smith, J. J., and K. van den Broek. 2005. Feasibility of using fishwheels for long-term monitoring of Chinook salmon escapement on the Copper River, 2004 annual report. U.S. Fish and Wildlife Service, Office of Subsistence Management, Fisheries Resource Monitoring Program (Study No. 04-503), Anchorage, Alaska.

Sturhahn, J. C., and D. A. Nagtegaal. 1999. Results of the chinook assessment study conducted on the Klinaklini River during 1998. Can. Manuscr. Rep. Fish. Aquat. Sci. 2497: x + 18.

Wuttig, K. G., and M. J. Evenson. 2001. Inriver abundance, spawning distribution, and migratory timing of Copper River Chinook salmon in 2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-22, Anchorage.

Zar, J. H. 1984. Biostatistical analysis, 2nd edition. Prentice-Hall, Inc., New Jersey. 718 p.

FIGURES

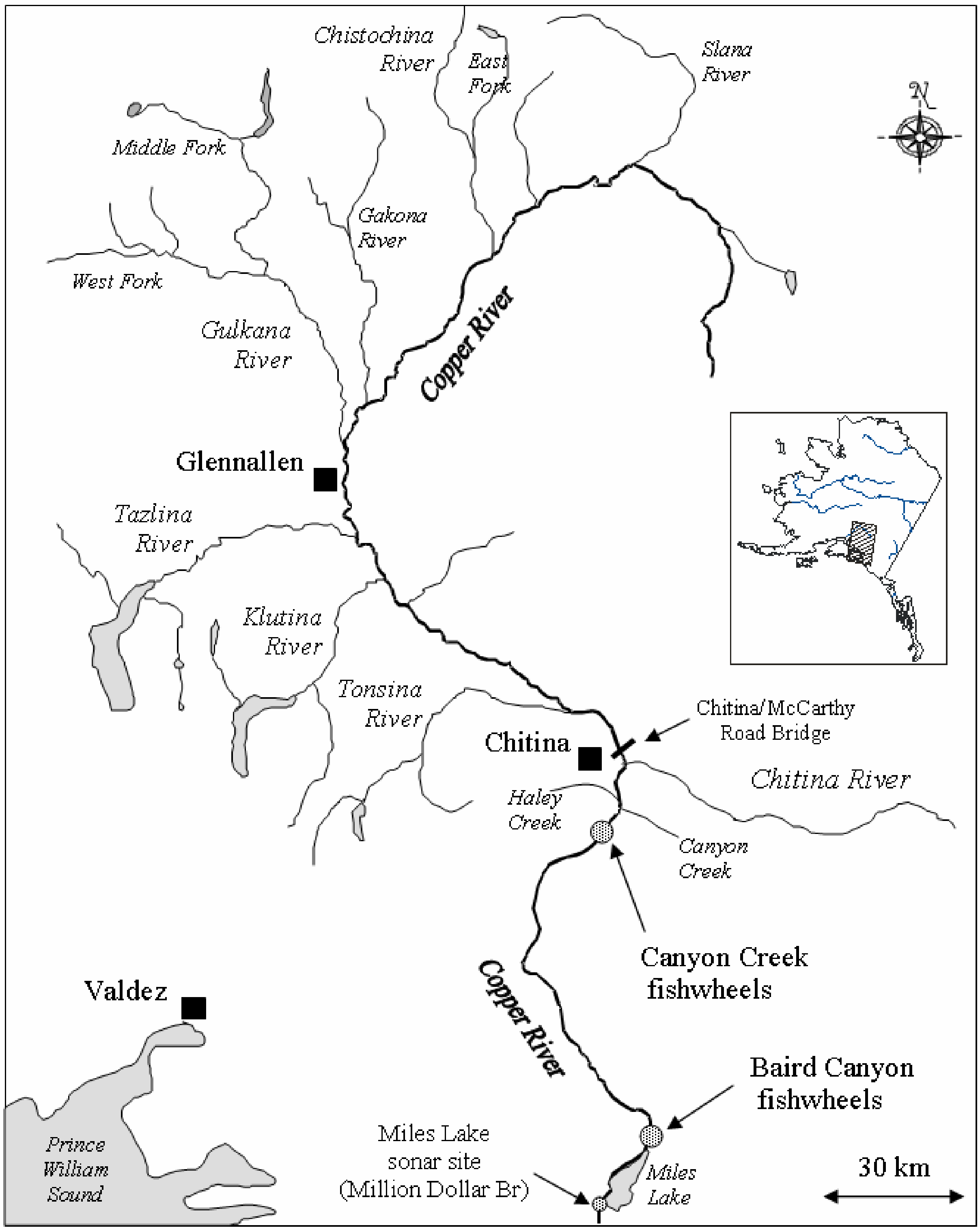

Figure 1. Map of the study area showing the location of the Baird Canyon and Canyon Creek fishwheels on the Copper River in Alaska, 2005.

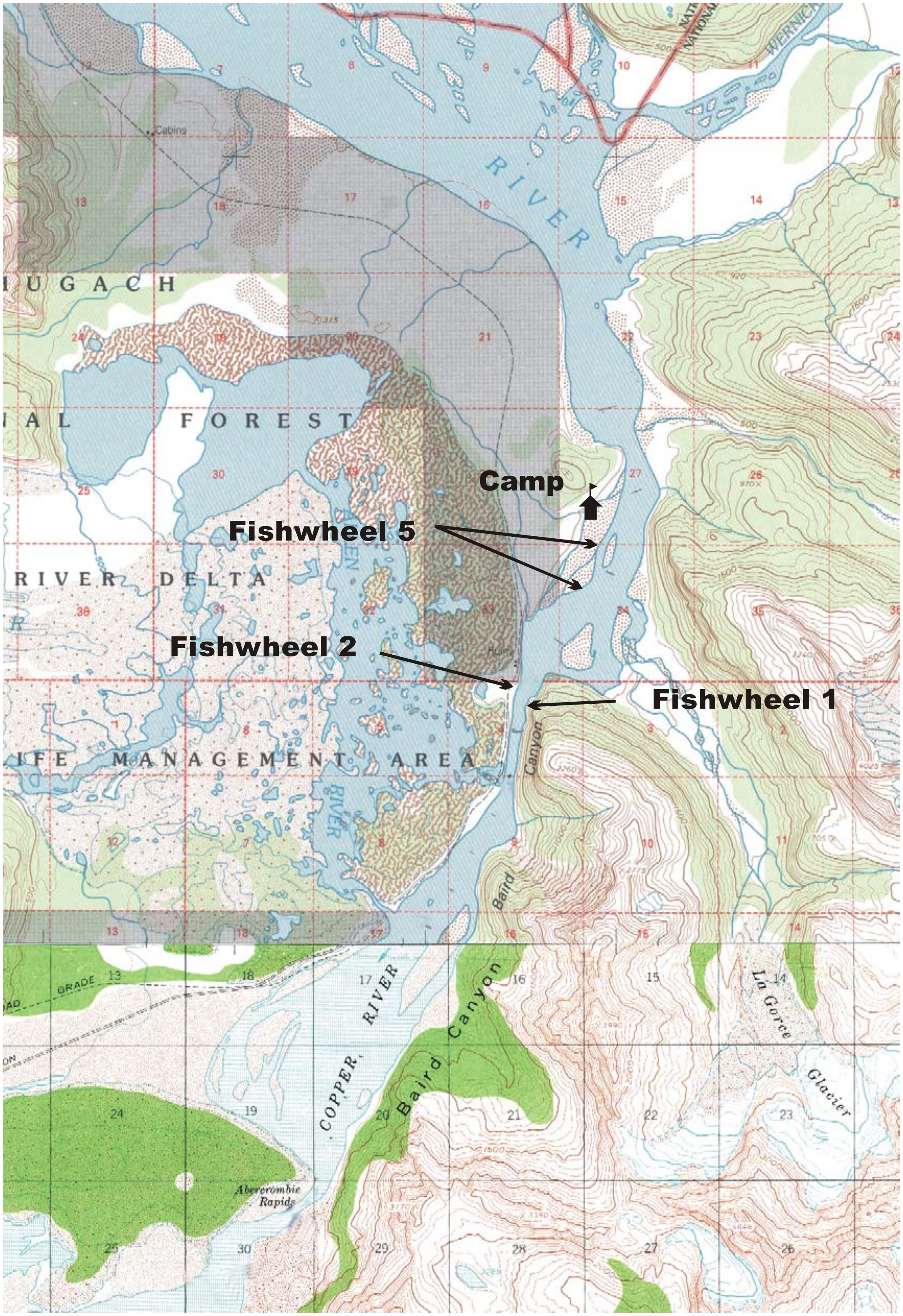

Figure 2. Map of Baird Canyon on the Copper River showing the location of the camp and fishwheel sites that were used in 2005.

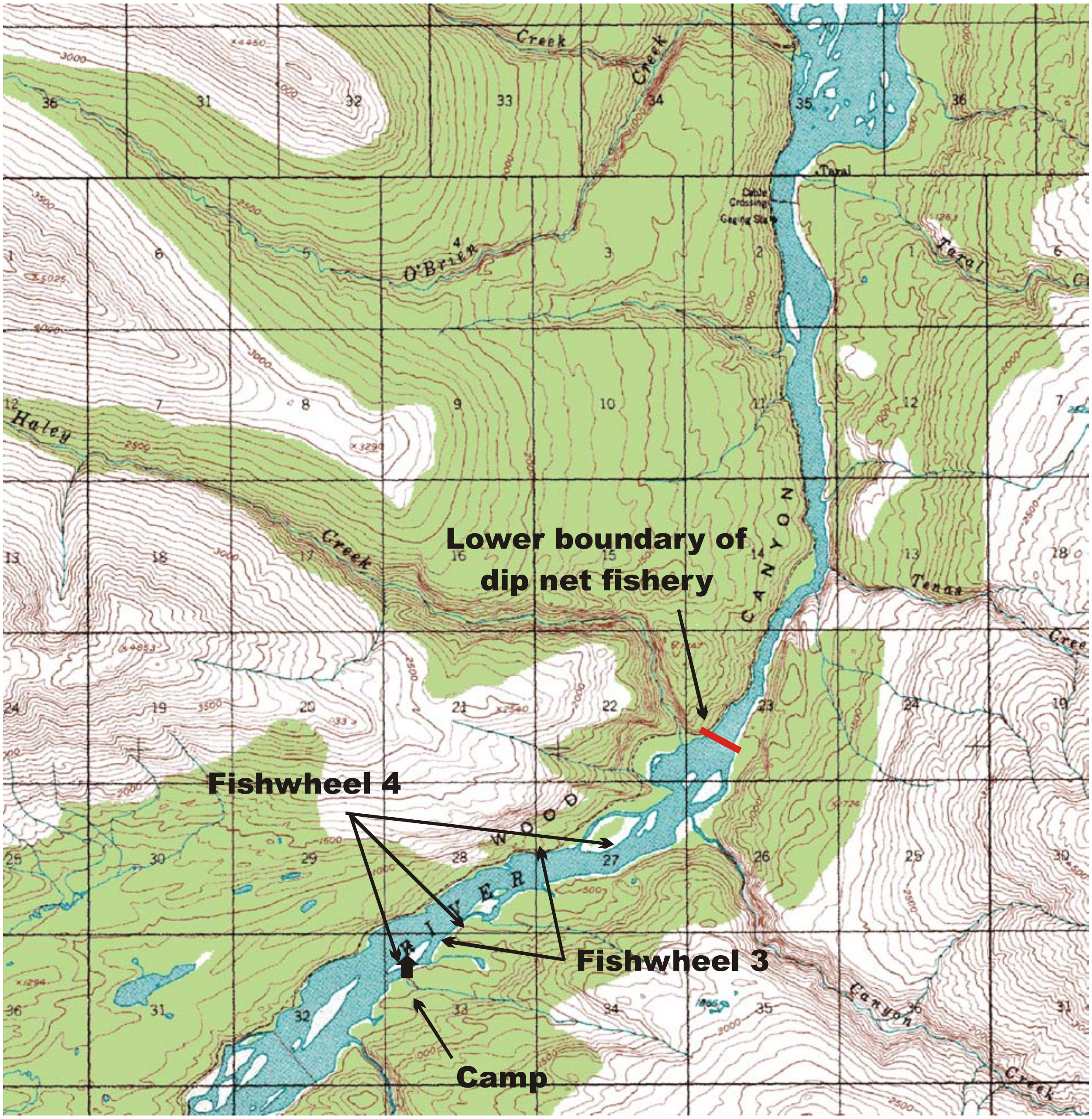

Figure 3. Map of Wood Canyon on the Copper River showing the location of the camp, fishwheel sites that were used in 2005, and the lower boundary of the Chitina Subdistrict dip net (CSDN) fishery.

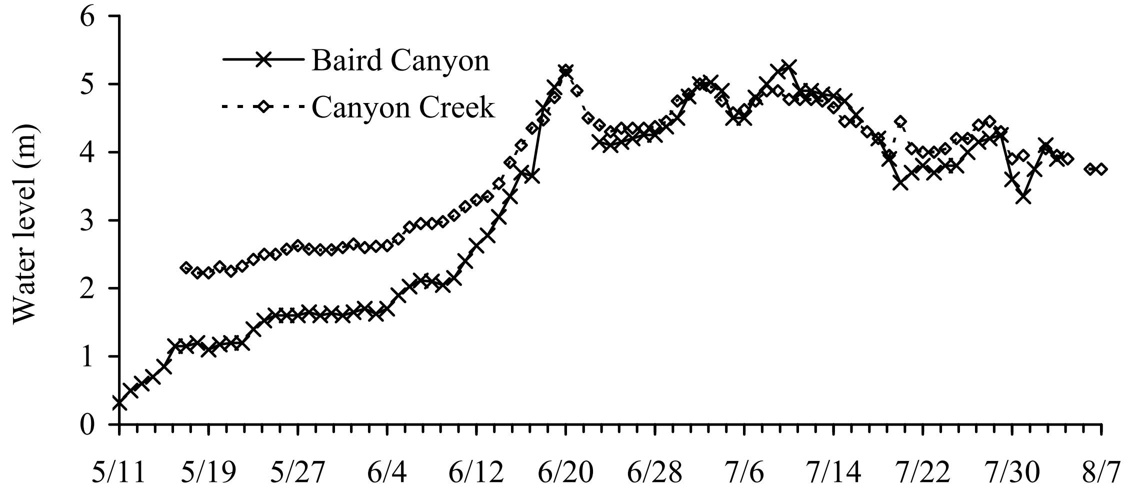

Figure 4. Average daily water level of the Copper River near the Baird Canyon and Canyon Creek fishwheels, 2005.

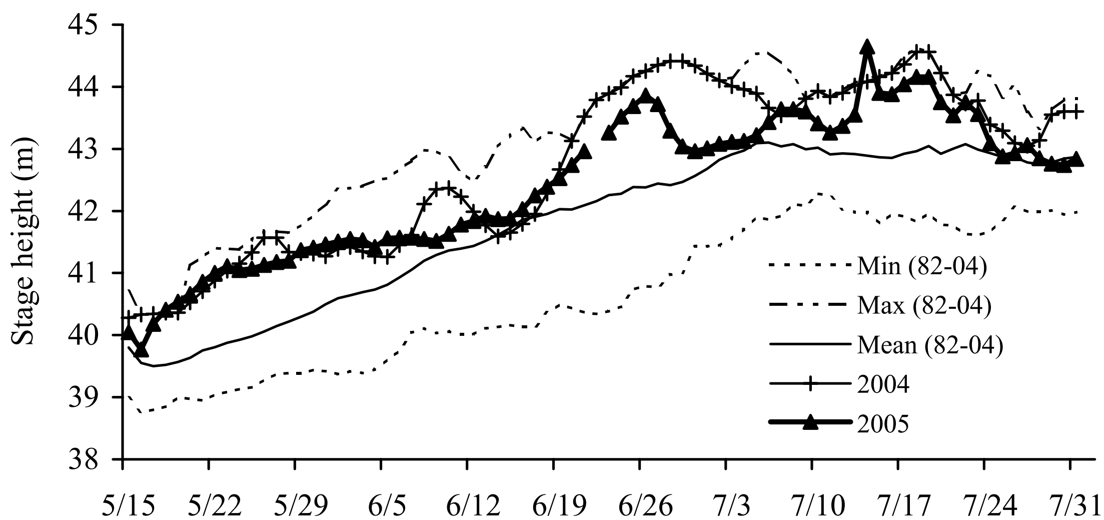

Figure 5. Stage height of the Copper River at the Million Dollar Bridge, 1982 to 2005.

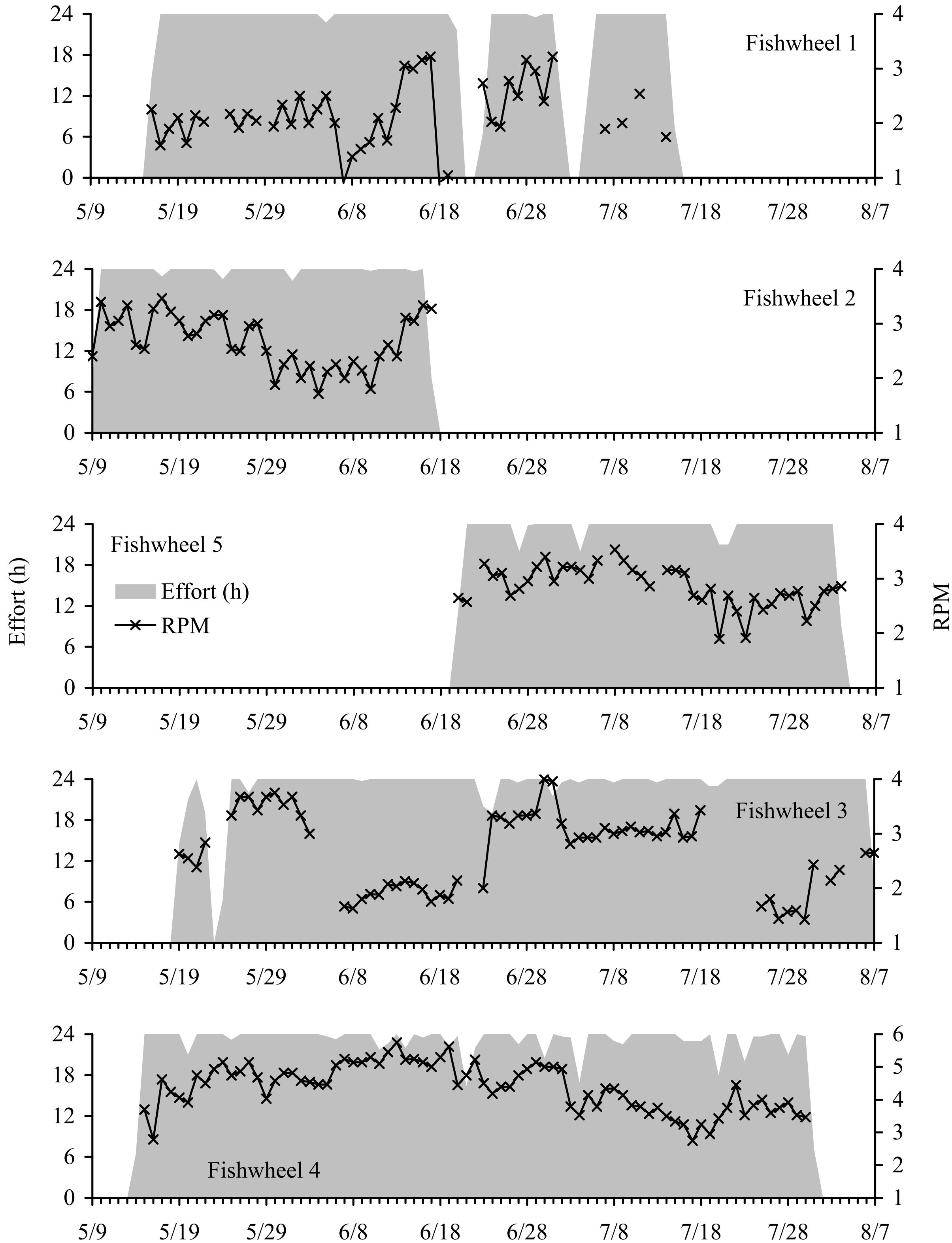

Figure 6. Fishwheel effort (h) and speed (rpm) at the Baird Canyon (fw 1, 2, and 5) and Canyon Creek (fw 3 and 4) fishwheels on the Copper River, 2005.

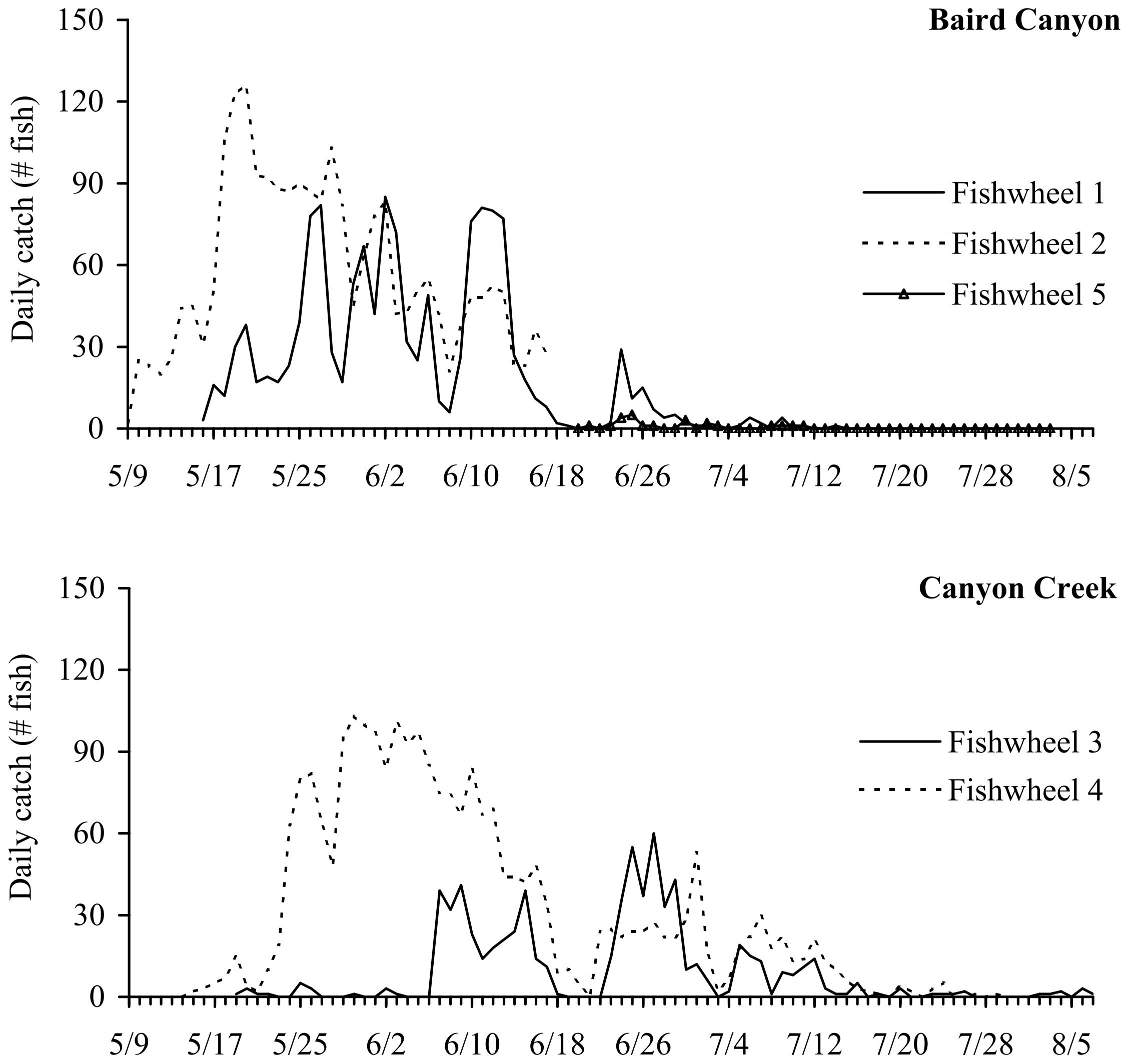

Figure 7. Daily catch of Chinook salmon at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

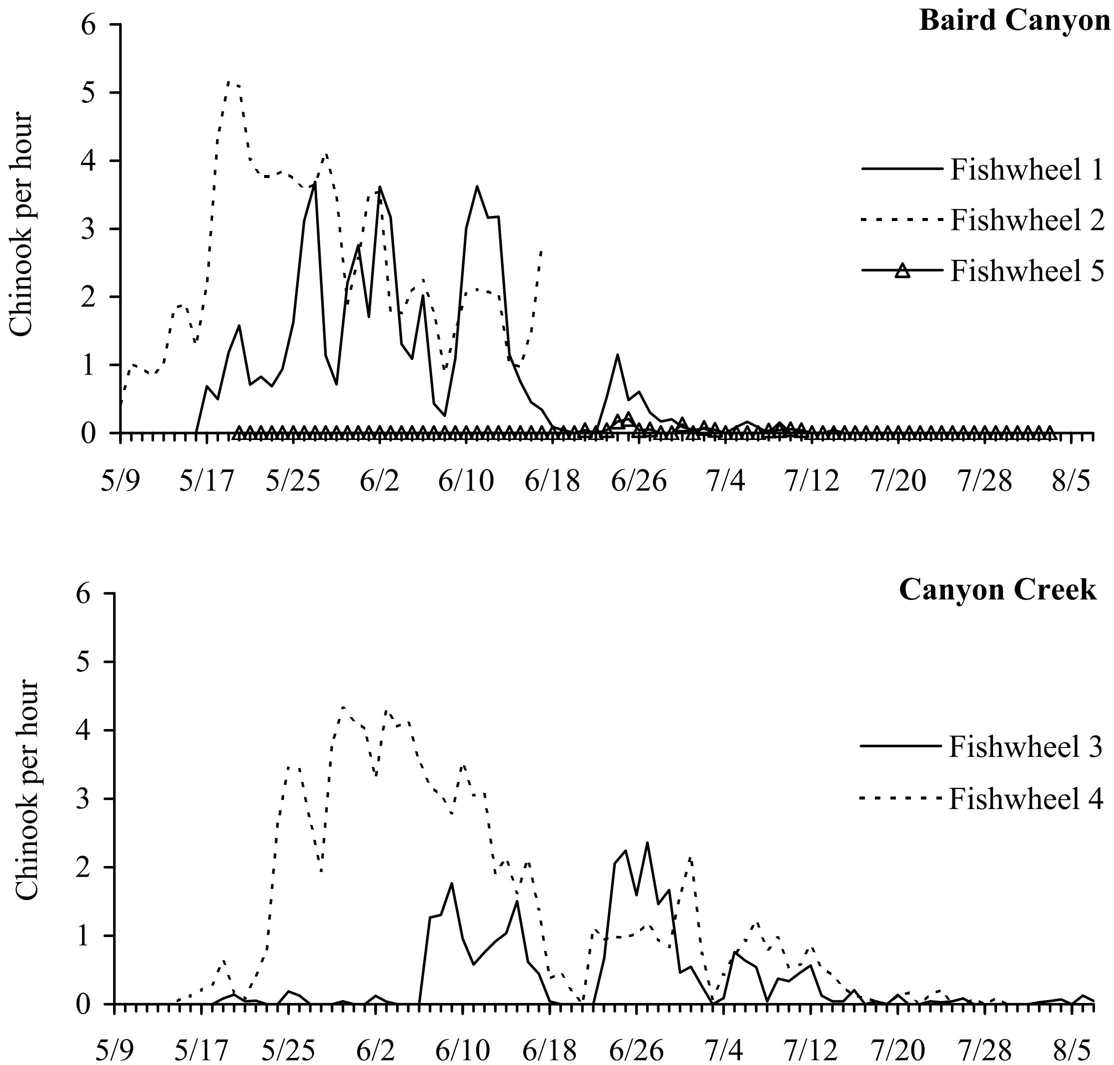

Figure 8. Catch per unit effort (fish per fishwheel hour) for Chinook salmon at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

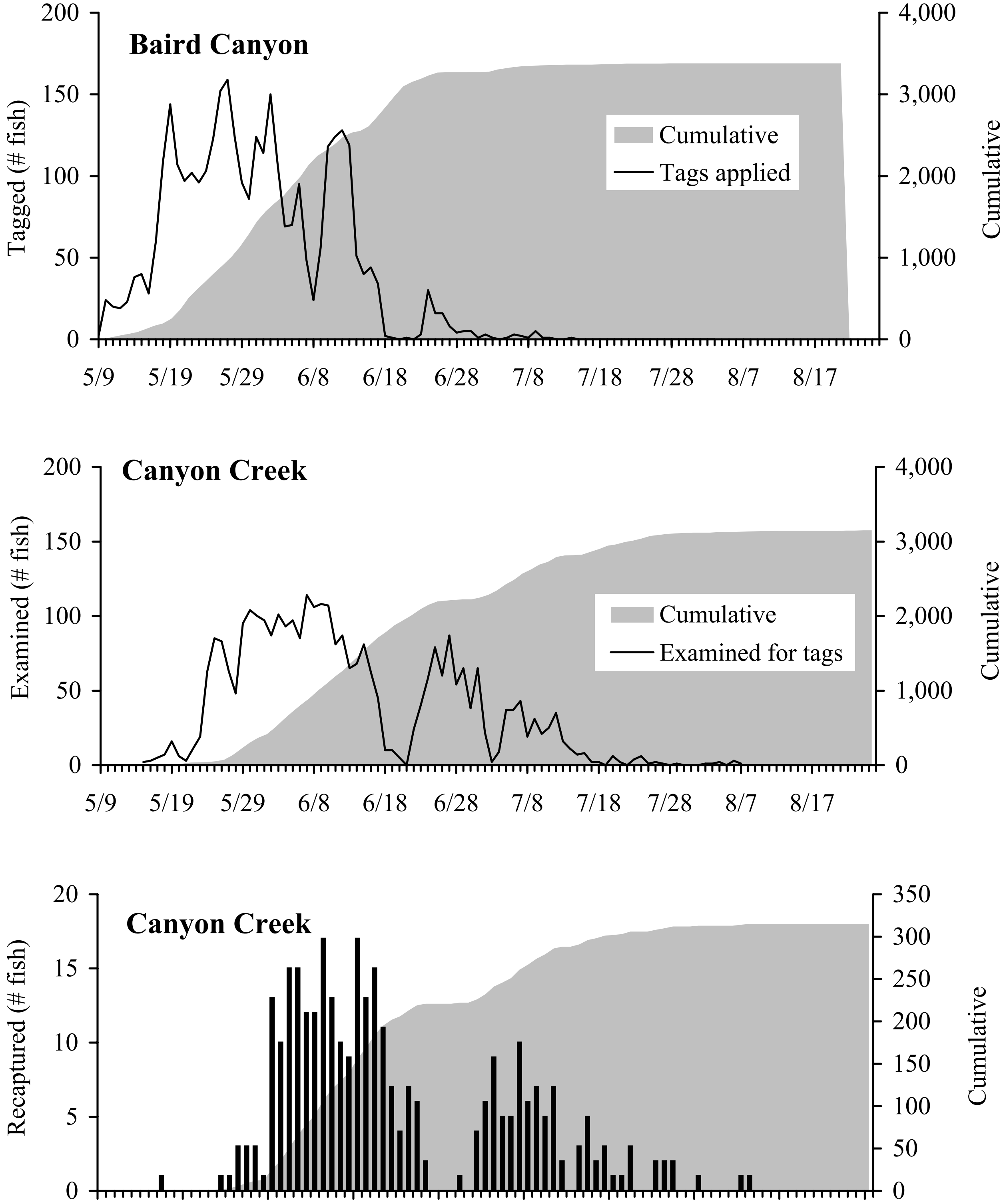

Figure 9. Number of Chinook salmon marked, examined, and recaptured at the Copper River fishwheels, 2005.

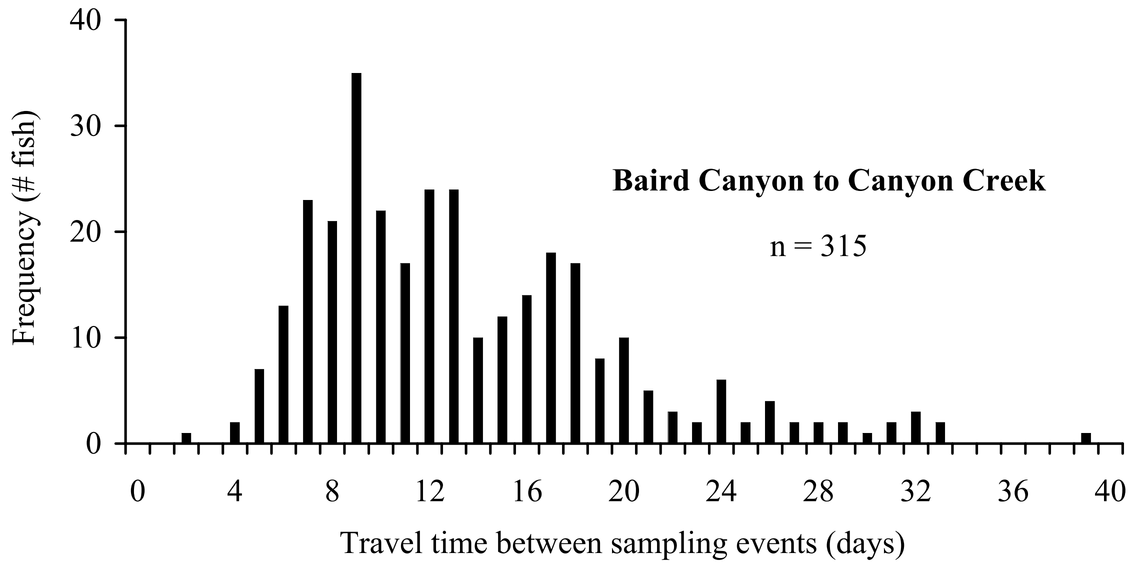

Figure 10. Travel time (days) of Chinook salmon that were tagged at the Baird Canyon fishwheels and recaptured at the Canyon Creek fishwheels, 2005.

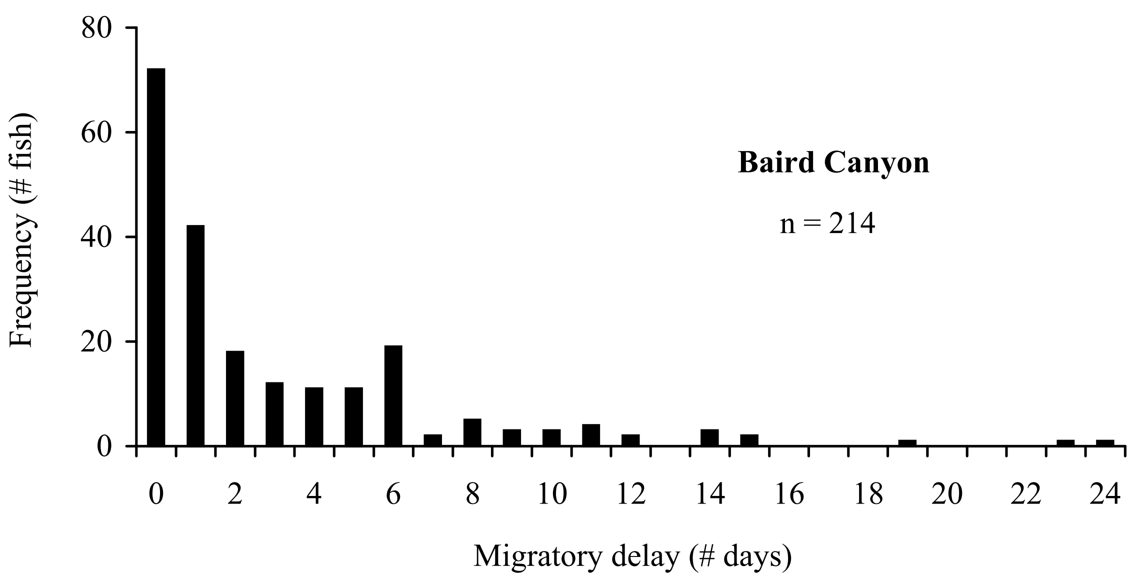

Figure 11. Migratory delay for Chinook salmon captured twice at the Baird Canyon fishwheels, 2005.

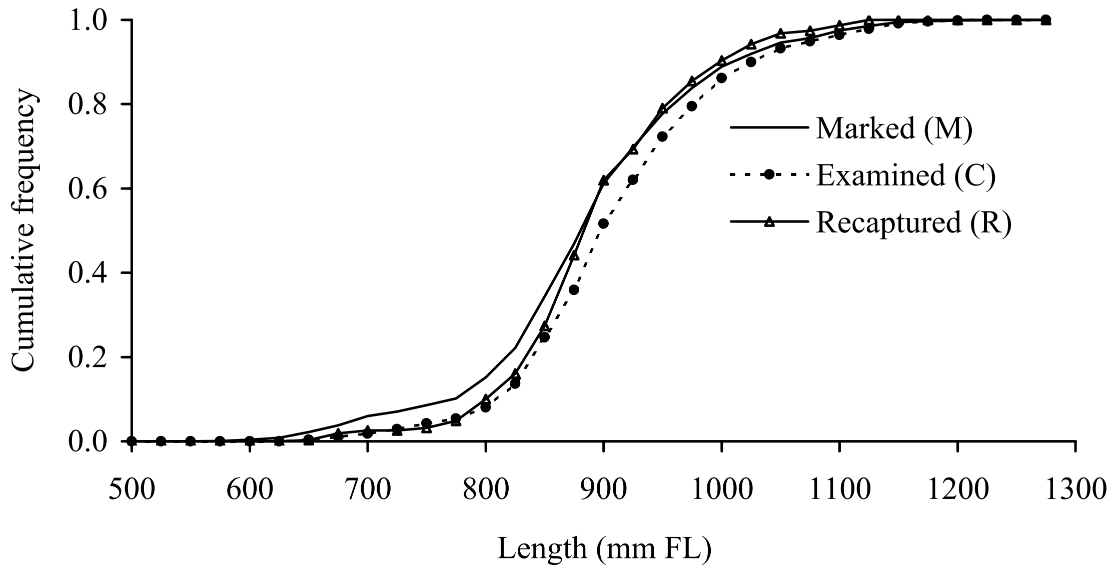

Figure 12. Cumulative length-frequency distributions of Chinook salmon (≥ 600 mm FL) marked at Baird Canyon and examined and recaptured at Canyon Creek,

TABLES

Table 1. Capture history for Chinook salmon sampled during the first event (Baird Canyon) that were used to estimate inriver abundance, 2005.

Capture history	Fishwheel 1	Fishwheel 2	Fishwheel 5	Total
Total number captured	1,357	2,294	23	3,674
<u>Untagged fish</u>				
Escaped prior to applying both marks	57	89	1	147
Visible injury or stress	54	83	0	137
Coded-wire tag (CWT)	1	2	0	3
Mortality	0	6	0	6
FL < 600 mm FL	2	0	0	2
Total untagged fish	114	180	1	295
Tagged fish (primary & secondary marks)	1,243	2,114	22	3,379

Table 2. Capture history for Chinook salmon sampled during the second event (Canyon Creek) that were used to estimate inriver abundance, 2005.

Capture history	Fishwheel 3	Fishwheel 4	Total
Total number captured	722	2,436	3,158
Escaped before examination complete	2	6	8
Examined for tags	658	2,177	3,150
Recaptures	62	253	315

Table 3. Number of Chinook salmon recaptured by bank of release and the results of a test to compare recapture rates for fish marked on the east and west banks, 2005.

	Bank of release	
History of recapture	West	East
Recaptured	186	129
Not recaptured	1,950	1,114

Chi-square = 2.59; df = 1; P-value = 0.107

Table 4. Capture history of Chinook salmon that were marked and examined at the Copper River fishwheels, 2005.

	Period of recapture												
Period of marking	5/15-5/22	5/23-5/30	5/31-6/7	6/8-6/15	6/16-6/23	6/24-7/1	7/2-7/9	7/10-7/17	7/18-8/7	Recaptured	Not recaptured	Marks	Recapture rate
5/9-5/15	1	11	4	2	0	0	0	0	0	**18**	**148**	166	0.108
5/16-5/22	0	22	26	4	0	0	0	0	0	**52**	**595**	647	0.080
5/23-5/29	0	2	64	26	2	2	0	0	0	**96**	**757**	853	0.113
5/30-6/5	0	0	9	44	7	8	4	1	0	**73**	**647**	720	0.101
6/6-6/12	0	0	0	4	4	35	4	2	0	**49**	**545**	594	0.082
6/13-6/19	0	0	0	0	0	9	6	4	0	**19**	**272**	291	0.065
6/20-6/26	0	0	0	0	0	0	3	2	1	**6**	**60**	66	0.091
6/27-7/14	0	0	0	0	0	0	0	0	2	**2**	**40**	42	0.048
Recaps	**1**	**35**	**103**	**80**	**13**	**54**	**17**	**9**	**3**	315	3064	3379	0.093
Unmarked	**52**	**525**	**671**	**623**	**183**	**452**	**183**	**116**	**30**	2835	$\chi^2 = 11$, df = 7, P = 0.16		
Examined	53	560	774	703	196	506	200	125	33	3150			
Mark rate	0.019	0.063	0.133	0.114	0.066	0.107	0.085	0.072	0.091	0.100	$\chi^2 = 28$, df = 8, P = 0.00		

Bold text indicates data used for chi-square tests.

Table 5. Estimated inriver abundance of Chinook salmon above Baird Canyon on the Copper River, 2003-2005.

Year	Period (m/d) From	Period (m/d) To	Length (mm FL)	Marked (M)	Examined (C)	Recaptures (R)	Abundance (N)	Standard Error (SE)
2003	5/17	7/1	810-1,070	1,723	1,630	97	44,764	12,506
2004	5/22	6/22	≥ 600	2,477	3,101	185	40,564	4,650
2005	5/9	7/14	≥ 600	3,379	3,150	315	30,333	1,529

APPENDICES

Appendix A.1. Summary of daily fishwheel effort (h), effort used to calculate catch per unit effort (CPUE), and fishwheel speed (RPM) for the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM
9-May				7.7	4.7	2.4									
10-May				24.0	24.7	3.4									
11-May				24.0	24.1	3.0									
12-May				24.0	23.8	3.1									
13-May				24.0	24.2	3.3									
14-May				24.0	24.0	2.6							6.5		
15-May				24.0	23.8	2.5							24.0	27.6	3.7
16-May	14.8		2.3	24.0	24.2	3.3							24.0	24.2	2.8
17-May	24.0	23.4	1.6	22.9	23.2	3.5							24.0	24.2	4.6
18-May	24.0	24.2	1.9	24.0	24.4	3.2							24.0	24.3	4.2
19-May	24.0	25.3	2.1	24.0	23.9	3.1				14.5	11.6	2.6	24.0	23.5	4.1
20-May	24.0	24.1	1.6	24.0	24.8	2.8				21.0	21.4	2.5	21.0	21.3	3.9
21-May	24.0	23.9	2.1	24.0	23.2	2.8				24.0	23.4	2.4	24.0	23.5	4.7
22-May	24.0	23.0	2.0	24.0	24.5	3.1				19.1	18.9	2.8	24.0	24.0	4.5
23-May	24.0	24.9		23.9	23.3	3.2							24.0	24.2	4.9
24-May	24.0	24.5		22.5	22.7	3.2				6.3			24.0	23.9	5.1
25-May	24.0	24.0	2.2	24.0	24.1	2.5				24.0	26.6	3.3	23.2	23.2	4.7
26-May	24.0	25.0	1.9	24.0	24.3	2.5				24.0	23.7	3.7	24.0	24.0	4.9
27-May	24.0	22.2	2.2	24.0	23.0	3.0				22.0	21.1	3.7	24.0	23.9	5.1
28-May	24.0	24.6	2.0	24.0	25.0	3.0				24.0	25.1	3.4	24.0	24.6	4.7
29-May	24.0	23.8		24.0	23.7	2.5				24.0	21.0	3.7	24.0	24.9	4.0
30-May	24.0	24.1	1.9	24.0	23.6	1.9				24.0	23.9	3.8	24.0	23.8	4.6
31-May	24.0	24.3	2.3	24.0	24.6	2.3				24.0	24.1	3.5	24.0	24.1	4.8
1-Jun	24.0	24.6	2.0	22.3	22.3	2.4				24.0	23.5	3.7	24.0	24.2	4.8
2-Jun	24.0	23.5	2.5	24.0	23.4	2.0				24.0	24.5	3.3	24.0	25.4	4.6
3-Jun	24.0	22.8	2.0	24.0	23.5	2.2				24.0	26.1	3.0	24.0	23.4	4.5
4-Jun	24.0	24.5	2.3	24.0	24.4	1.7				24.0	20.8		24.0	22.9	4.5

Appendix A.1. Summary of daily fishwheel effort (h), effort used to calculate catch per unit effort (CPUE), and fishwheel speed (RPM) for the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM
5-Jun	22.8	23.0	2.5	24.0	24.0	2.1				24.0	24.0		23.7	23.5	4.5
6-Jun	24.0	24.3	2.0	24.0	24.6	2.3				24.0	24.0		23.3	23.9	5.0
7-Jun	24.0	23.1	0.9	24.0	23.4	2.0				24.0	30.8	1.7	24.0	23.5	5.2
8-Jun	24.0	23.8	1.4	24.0	23.7	2.3				24.0	24.6	1.6	24.0	24.3	5.1
9-Jun	24.0	23.8	1.5	24.0	24.6	2.1				23.8	23.2	1.8	24.0	24.0	5.1
10-Jun	24.0	25.3	1.7	23.8	23.5	1.8				24.0	24.0	1.9	24.0	23.8	5.3
11-Jun	24.0	22.4	2.1	24.0	22.8	2.4				24.0	24.1	1.9	21.8	22.0	5.1
12-Jun	24.0	25.3	1.7	24.0	25.1	2.6				24.0	23.8	2.1	22.7	22.5	5.5
13-Jun	24.0	24.3	2.3	24.0	24.7	2.4				24.0	22.9	2.0	24.0	23.0	5.7
14-Jun	24.0	23.5	3.1	24.0	23.4	3.1				24.0	23.1	2.1	22.0	20.7	5.2
15-Jun	24.0	23.9	3.0	23.7	23.7	3.1				24.0	25.9	2.1	24.0	25.8	5.2
16-Jun	24.0	24.5	3.2	24.0	24.1	3.3				24.0	22.7	2.0	23.5	22.7	5.1
17-Jun	24.0	23.5	3.2	8.0	10.3	3.3				24.0	24.8	1.8	24.0	24.6	5.0
18-Jun	24.0	22.8	0.9							24.0	23.7	1.9	24.0	23.9	5.3
19-Jun	24.0	25.0	1.0							24.0	24.1	1.8	22.3	21.9	5.6
20-Jun	21.7	21.9					11.5	10.4	2.6	24.0	22.9	2.1	23.8	23.9	4.4
21-Jun							24.0	22.6	2.6	24.0	24.8		16.4	16.9	4.7
22-Jun							24.0	23.7		24.0	23.5		22.0	21.6	5.2
23-Jun	6.6	3.8	2.7				24.0	24.5	3.3	20.0	22.5	2.0	24.0	26.5	4.5
24-Jun	24.0	25.2	2.0				24.0	23.9	3.1	19.0	17.5	3.3	24.0	22.4	4.2
25-Jun	24.0	22.8	1.9				24.0	24.1	3.1	24.0	24.5	3.3	24.0	24.6	4.4
26-Jun	24.0	24.8	2.8				24.0	24.6	2.7	24.0	23.2	3.2	24.0	23.3	4.4
27-Jun	24.0	23.4	2.5				20.0	18.8	2.8	23.5	25.4	3.3	22.5	22.9	4.7
28-Jun	24.0	23.9	3.2				23.8	23.8	3.0	24.0	22.6	3.3	24.0	23.1	4.9
29-Jun	23.5	24.8	3.0				24.0	25.8	3.2	24.0	25.8	3.4	24.0	26.4	5.1
30-Jun	24.0	22.8	2.4				24.0	23.3	3.4	24.0	21.6	4.0	20.5	17.7	5.0
1-Jul	24.0	23.5	3.2				24.0	23.0	3.0	21.5	22.0	4.0	24.0	24.4	5.0
2-Jul	11.6	14.8					24.0	26.5	3.2	23.5	22.6	3.2	23.7	21.3	4.9

Appendix A.1. Summary of daily fishwheel effort (h), effort used to calculate catch per unit effort (CPUE), and fishwheel speed (RPM) for the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM
3-Jul							24.0	21.9	3.2	24.0	24.3	2.8	23.5	25.6	3.8
4-Jul							20.0	21.2	3.2	23.5	22.7	2.9	17.0	16.2	3.5
5-Jul	12.0	11.5					24.0	24.9	3.0	24.0	24.9	2.9	24.0	24.6	4.1
6-Jul	24.0	24.0					24.0	24.0	3.3	24.0	23.6	2.9	24.0	23.7	3.8
7-Jul	24.0	23.2	1.9				24.0	22.7		24.0	24.1	3.1	24.0	24.6	4.3
8-Jul	24.0	25.2					24.0	25.6	3.5	23.5	23.8	3.0	23.0	22.6	4.3
9-Jul	24.0	26.1	2.0				24.0	24.3	3.3	24.0	24.1	3.1	22.5	22.7	4.1
10-Jul	24.0	13.6					24.0	17.3	3.2	24.0	23.8	3.1	24.0	23.9	3.8
11-Jul	24.0	29.8	2.5				24.0	24.3	3.1	24.0	24.0	3.0	24.0	23.9	3.8
12-Jul	24.0	25.2					24.0	29.3	2.9	24.0	24.8	3.1	24.0	24.5	3.6
13-Jul	24.0	17.5					24.0	17.3		23.5	23.5	3.0	24.0	24.3	3.8
14-Jul	24.0	24.2	1.7				24.0	22.5	3.2	24.0	23.4	3.0	24.0	23.4	3.5
15-Jul	7.4	15.3					24.0	27.9	3.2	24.0	24.2	3.4	24.0	24.2	3.3
16-Jul							24.0	24.8	3.1	24.0	24.3	2.9	23.0	23.4	3.2
17-Jul							24.0	18.7	2.7	24.0	23.4	3.0	23.0	22.3	2.7
18-Jul							24.0	24.6	2.6	24.0	24.1	3.4	23.0	23.0	3.2
19-Jul							24.0	24.7	2.8	23.0	23.5		24.0	12.0	3.0
20-Jul							21.0	21.0	1.9	23.0	22.4	0.5	18.0	30.0	3.4
21-Jul							21.0	14.5	2.7	24.0	12.0	0.8	24.0	12.1	3.8
22-Jul							24.0	28.5	2.4	24.0	24.5		24.0	36.3	4.4
23-Jul							24.0	27.2	1.9	24.0	23.8	0.6	20.0	19.9	3.5
24-Jul							24.0	26.4	2.6	24.0	35.8		23.7	24.1	3.8
25-Jul							24.0	16.6	2.4	24.0	23.8	1.7	23.7	23.1	4.0
26-Jul							24.0	22.8	2.5	24.0	24.2	1.8	24.0	23.8	3.6
27-Jul							24.0	28.4	2.7	24.0	23.9	1.4	24.0	12.3	3.8
28-Jul							24.0	25.2	2.7	24.0	12.5	1.6	21.0	32.8	3.9
29-Jul							24.0	18.5	2.8	24.0	23.5	1.6	24.0	11.8	3.5
30-Jul							24.0	33.2	2.2	24.0	36.1	1.4	23.7	35.8	3.5

Appendix A.1. Summary of daily fishwheel effort (h), effort used to calculate catch per unit effort (CPUE), and fishwheel speed (RPM) for the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM	Total effort (h)	CPUE effort (h)	RPM
31-Jul							24.0	20.4	2.5	24.0	11.9	2.4	7.0	9.9	
1-Aug							24.0	28.5	2.8	24.0	26.9				
2-Aug							24.0	20.3	2.8	24.0	34.5	2.1			
3-Aug							9.2	13.8	2.9	24.0	21.4	2.3			
4-Aug										24.0	27.7				
5-Aug										24.0	12.5				
6-Aug										24.0	24.2	2.6			
7-Aug										9.2	21.0	2.6			
Effort (h)	1296		2.2	923		2.7	1039		2.9	1852		2.6	1807		4.4
Effort (d)	54.0			38.4			43.3			77.2			75.3		
Percent operational:															
	90.5%			99.5%			98.7%			96.5%			98.3%		

Appendix A.2. Total catch and catch per unit effort (fish per hour) for Chinook salmon at the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE
9 May				2	2	0.4									
10 May				25	27	1.0									
11 May				23	50	1.0									
12 May				20	70	0.8									
13 May				25	95	1.0									
14 May				44	139	1.8							0	0	
15 May				45	184	1.9							2	2	0.1
16 May	3	3		31	215	1.3							3	5	0.1
17 May	16	19	0.7	50	265	2.2							5	10	0.2
18 May	12	31	0.5	106	371	4.3							7	17	0.3
19 May	30	61	1.2	123	494	5.2				1	1	0.1	15	32	0.6
20 May	38	99	1.6	126	620	5.1				3	4	0.1	4	36	0.2
21 May	17	116	0.7	93	713	4.0				1	5	0.0	2	38	0.1
22 May	19	135	0.8	92	805	3.8				1	6	0.1	10	48	0.4
23 May	17	152	0.7	88	893	3.8				0	6		19	67	0.8
24 May	23	175	0.9	87	980	3.8				0	6		63	130	2.6
25 May	39	214	1.6	90	1,070	3.7				5	11	0.2	80	210	3.4
26 May	78	292	3.1	87	1,157	3.6				3	14	0.1	82	292	3.4
27 May	82	374	3.7	84	1,241	3.7				0	14	0.0	64	356	2.7
28 May	28	402	1.1	103	1,344	4.1				0	14	0.0	48	404	1.9
29 May	17	419	0.7	82	1,426	3.5				0	14	0.0	95	499	3.8
30 May	53	472	2.2	45	1,471	1.9				1	15	0.0	103	602	4.3
31 May	67	539	2.8	63	1,534	2.6				0	15	0.0	100	702	4.2
1 Jun	42	581	1.7	78	1,612	3.5				0	15	0.0	97	799	4.0
2 Jun	85	666	3.6	83	1,695	3.5				3	18	0.1	84	883	3.3

Appendix A.2. Total catch and catch per unit effort (fish per hour) for Chinook salmon at the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE
3 Jun	72	738	3.2	42	1,737	1.8				1	19	0.0	101	984	4.3
4 Jun	32	770	1.3	43	1,780	1.8				0	19	0.0	93	1,077	4.1
5 Jun	25	795	1.1	50	1,830	2.1				0	19	0.0	97	1,174	4.1
6 Jun	49	844	2.0	55	1,885	2.2				0	19	0.0	85	1,259	3.6
7 Jun	10	854	0.4	42	1,927	1.8				39	58	1.3	75	1,334	3.2
8 Jun	6	860	0.3	21	1,948	0.9				32	90	1.3	74	1,408	3.0
9 Jun	26	886	1.1	37	1,985	1.5				41	131	1.8	67	1,475	2.8
10 Jun	76	962	3.0	48	2,033	2.0				23	154	1.0	84	1,559	3.5
11 Jun	81	1,043	3.6	48	2,081	2.1				14	168	0.6	67	1,626	3.1
12 Jun	80	1,123	3.2	52	2,133	2.1				18	186	0.8	69	1,695	3.1
13 Jun	77	1,200	3.2	50	2,183	2.0				21	207	0.9	44	1,739	1.9
14 Jun	27	1,227	1.2	24	2,207	1.0				24	231	1.0	44	1,783	2.1
15 Jun	18	1,245	0.8	23	2,230	1.0				39	270	1.5	42	1,825	1.6
16 Jun	11	1,256	0.4	36	2,266	1.5				14	284	0.6	48	1,873	2.1
17 Jun	8	1,264	0.3	28	2,294	2.7				11	295	0.4	34	1,907	1.4
18 Jun	2	1,266	0.1							1	296	0.0	9	1,916	0.4
19 Jun	1	1,267	0.0							0	296	0.0	10	1,926	0.5
20 Jun	0	1,267	0.0				0	0	0.0	0	296	0.0	5	1,931	0.2
21 Jun	0	1,267					1	1	0.0	0	296	0.0	0	1,931	0.0
22 Jun	0	1,267					0	1	0.0	0	296	0.0	24	1,955	1.1
23 Jun	2	1,269	0.5				1	2	0.0	15	311	0.7	25	1,980	0.9
24 Jun	29	1,298	1.2				4	6	0.2	36	347	2.1	22	2,002	1.0
25 Jun	11	1,309	0.5				5	11	0.2	55	402	2.2	24	2,026	1.0
26 Jun	15	1,324	0.6				1	12	0.0	37	439	1.6	24	2,050	1.0
27 Jun	7	1,331	0.3				1	13	0.1	60	499	2.4	27	2,077	1.2

Appendix A.2. Total catch and catch per unit effort (fish per hour) for Chinook salmon at the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE
28 Jun	4	1,335	0.2				0	13	0.0	33	532	1.5	22	2,099	1.0
29 Jun	5	1,340	0.2				0	13	0.0	43	575	1.7	22	2,121	0.8
30 Jun	2	1,342	0.1				3	16	0.1	10	585	0.5	28	2,149	1.6
1 Jul	1	1,343	0.0				0	16	0.0	12	597	0.5	53	2,202	2.2
2 Jul	1	1,344	0.1				2	18	0.1	6	603	0.3	16	2,218	0.8
3 Jul	0	1,344					1	19	0.0	0	603	0.0	2	2,220	0.1
4 Jul	0	1,344					0	19	0.0	2	605	0.1	7	2,227	0.4
5 Jul	1	1,345	0.1				0	19	0.0	19	624	0.8	18	2,245	0.7
6 Jul	4	1,349	0.2				0	19	0.0	15	639	0.6	22	2,267	0.9
7 Jul	2	1,351	0.1				0	19	0.0	13	652	0.5	30	2,297	1.2
8 Jul	0	1,351	0.0				1	20	0.0	1	653	0.0	18	2,315	0.8
9 Jul	4	1,355	0.2				1	21	0.0	9	662	0.4	22	2,337	1.0
10 Jul	0	1,355	0.0				1	22	0.1	8	670	0.3	13	2,350	0.5
11 Jul	1	1,356	0.0				1	23	0.0	11	681	0.5	14	2,364	0.6
12 Jul	0	1,356	0.0				0	23	0.0	14	695	0.6	21	2,385	0.9
13 Jul	0	1,356	0.0				0	23	0.0	3	698	0.1	13	2,398	0.5
14 Jul	1	1,357	0.0				0	23	0.0	1	699	0.0	10	2,408	0.4
15 Jul	0	1,357	0.0				0	23	0.0	1	700	0.0	6	2,414	0.2
16 Jul							0	23	0.0	5	705	0.2	3	2,417	0.1
17 Jul							0	23	0.0	0	705	0.0	2	2,419	0.1
18 Jul							0	23	0.0	1	706	0.0	1	2,420	0.0
19 Jul							0	23	0.0	0	706	0.0	0	2,420	0.0
20 Jul							0	23	0.0	3	709	0.1	4	2,424	0.1
21 Jul							0	23	0.0	0	709	0.0	2	2,426	0.2
22 Jul							0	23	0.0	0	709	0.0	0	2,426	0.0

Appendix A.2. Total catch and catch per unit effort (fish per hour) for Chinook salmon at the Copper River fishwheels, 2005.

	Baird Canyon									Canyon Creek					
	Fishwheel 1			Fishwheel 2			Fishwheel 5			Fishwheel 3			Fishwheel 4		
Date	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE	Catch	Cum.	CPUE
23 Jul							0	23	0.0	1	710	0.0	3	2,429	0.2
24 Jul							0	23	0.0	1	711	0.0	5	2,434	0.2
25 Jul							0	23	0.0	1	712	0.0	0	2,434	0.0
26 Jul							0	23	0.0	2	714	0.1	0	2,434	0.0
27 Jul							0	23	0.0	0	714	0.0	1	2,435	0.1
28 Jul							0	23	0.0	0	714	0.0	0	2,435	0.0
29 Jul							0	23	0.0	0	714	0.0	1	2,436	0.1
30 Jul							0	23	0.0	0	714	0.0	0	2,436	0.0
31 Jul							0	23	0.0	0	714	0.0	0	2,436	0.0
1 Aug							0	23	0.0	0	714	0.0			
2 Aug							0	23	0.0	1	715	0.0			
3 Aug							0	23	0.0	1	716	0.0			
4 Aug										2	718	0.1			
5 Aug										0	718	0.0			
6 Aug										3	721	0.1			
7 Aug										1	722	0.0			
Total	1,357			2,294			23			722			2,436		

Fish captured twice at either the Baird Canyon (216 fish) or Canyon Creek (19 fish) fishwheels were not included in the total catch.

Appendix A.3. Number of Chinook salmon tagged, examined and recaptured at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

	Baird Canyon						Canyon Creek							
	Fishwheel 1		Fishwheel 2		Fishwheel 5		Fishwheel 3				Fishwheel 4			
Date	Tags	Cum	Tags	Cum	Tags	Cum	Exam	Cum	Recap	Cum	Exam	Cum	Recap	Cum
9 May			2	2										
10 May			24	26										
11 May			20	46										
12 May			19	65										
13 May			23	88										
14 May			38	126										
15 May			40	166							2	2	0	0
16 May	3	3	25	191							3	5	1	1
17 May	15	18	45	236							5	10	0	1
18 May	9	27	100	336							7	17	0	1
19 May	26	53	118	454			1	1	0	0	15	32	0	1
20 May	22	75	85	539			3	4	0	0	3	35	0	1
21 May	15	90	82	621			1	5	0	0	2	37	0	1
22 May	17	107	85	706			1	6	0	0	10	47	0	1
23 May	16	123	80	786			0	6	0	0	19	66	1	2
24 May	20	143	83	869			0	6	0	0	63	129	1	3
25 May	35	178	88	957			5	11	0	0	80	209	3	6
26 May	69	247	83	1,040			3	14	0	0	80	289	3	9
27 May	79	326	80	1,120			0	14	0	0	63	352	3	12
28 May	26	352	98	1,218			0	14	0	0	48	400	1	13
29 May	15	367	81	1,299			0	14	0	0	95	495	13	26
30 May	44	411	42	1,341			1	15	0	0	103	598	10	36
31 May	63	474	61	1,402			0	15	0	0	100	698	15	51
1 Jun	38	512	76	1,478			0	15	0	0	97	795	15	66

Appendix A.3. Number of Chinook salmon tagged, examined and recaptured at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

	Baird Canyon						Canyon Creek							
	Fishwheel 1		Fishwheel 2		Fishwheel 5		Fishwheel 3				Fishwheel 4			
Date	Tags	Cum	Tags	Cum	Tags	Cum	Exam	Cum	Recap	Cum	Exam	Cum	Recap	Cum
2 Jun	78	590	72	1,550			3	18	0	0	84	879	12	78
3 Jun	66	656	41	1,591			1	19	0	0	100	979	12	90
4 Jun	29	685	40	1,631			0	19	0	0	93	1,072	17	107
5 Jun	23	708	47	1,678			0	19	0	0	97	1,169	13	120
6 Jun	45	753	50	1,728			0	19	0	0	85	1,254	10	130
7 Jun	9	762	40	1,768			39	58	3	3	75	1,329	6	136
8 Jun	6	768	18	1,786			32	90	7	10	74	1,403	10	146
9 Jun	23	791	33	1,819			41	131	4	14	67	1,470	9	155
10 Jun	73	864	45	1,864			23	154	5	19	84	1,554	10	165
11 Jun	77	941	47	1,911			14	168	2	21	67	1,621	9	174
12 Jun	77	1,018	51	1,962			18	186	2	23	69	1,690	5	179
13 Jun	74	1,092	45	2,007			21	207	1	24	44	1,734	3	182
14 Jun	27	1,119	24	2,031			24	231	3	27	44	1,778	4	186
15 Jun	17	1,136	23	2,054			39	270	5	32	42	1,820	1	187
16 Jun	10	1,146	34	2,088			14	284	1	33	48	1,868	1	188
17 Jun	8	1,154	26	2,114			11	295	0	33	34	1,902	0	188
18 Jun	2	1,156					1	296	0	33	9	1,911	0	188
19 Jun	1	1,157					0	296	0	33	10	1,921	0	188
20 Jun	0	1,157			0	0	0	296	0	33	5	1,926	1	189
21 Jun	0	1,157			1	1	0	296	0	33	0	1,926	0	189
22 Jun	0	1,157			0	1	0	296	0	33	24	1,950	4	193
23 Jun	2	1,159			1	2	15	311	2	35	25	1,975	4	197
24 Jun	27	1,186			3	5	36	347	2	37	22	1,997	7	204
25 Jun	11	1,197			5	10	55	402	3	40	24	2,021	2	206

Appendix A.3. Number of Chinook salmon tagged, examined and recaptured at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

	Baird Canyon						Canyon Creek							
	Fishwheel 1		Fishwheel 2		Fishwheel 5		Fishwheel 3				Fishwheel 4			
Date	Tags	Cum	Tags	Cum	Tags	Cum	Exam	Cum	Recap	Cum	Exam	Cum	Recap	Cum
26 Jun	15	1,212			1	11	36	438	1	41	24	2,045	4	210
27 Jun	7	1,219			1	12	60	498	7	48	27	2,072	3	213
28 Jun	4	1,223			0	12	32	530	4	52	22	2,094	2	215
29 Jun	5	1,228			0	12	43	573	4	56	22	2,116	3	218
30 Jun	2	1,230			3	15	10	583	1	57	28	2,144	4	222
1 Jul	1	1,231			0	15	12	595	1	58	53	2,197	6	228
2 Jul	1	1,232			2	17	6	601	0	58	16	2,213	2	230
3 Jul	0	1,232			1	18	0	601	0	58	2	2,215	0	230
4 Jul	0	1,232			0	18	2	603	1	59	7	2,222	2	232
5 Jul	1	1,233			0	18	19	622	3	62	18	2,240	2	234
6 Jul	3	1,236			0	18	15	637	0	62	22	2,262	2	236
7 Jul	2	1,238			0	18	13	650	0	62	30	2,292	3	239
8 Jul	0	1,238			1	19	1	651	0	62	18	2,310	1	240
9 Jul	4	1,242			1	20	9	660	0	62	22	2,332	1	241
10 Jul	0	1,242			1	21	8	668	0	62	13	2,345	3	244
11 Jul	0	1,242			1	22	11	679	0	62	14	2,359	0	244
12 Jul	0	1,242			0	22	14	693	0	62	21	2,380	0	244
13 Jul	0	1,242			0	22	3	696	0	62	13	2,393	2	246
14 Jul	1	1,243			0	22	1	697	0	62	10	2,403	2	248
15 Jul	0	1,243			0	22	1	698	0	62	6	2,409	2	250
16 Jul					0	22	5	703	0	62	3	2,412	0	250
17 Jul					0	22	0	703	0	62	2	2,414	0	250
18 Jul					0	22	1	704	0	62	1	2,415	1	251
19 Jul					0	22	0	704	0	62	0	2,415	0	251

Appendix A.3. Number of Chinook salmon tagged, examined and recaptured at the Baird Canyon and Canyon Creek fishwheels on the Copper River, 2005.

	Baird Canyon						Canyon Creek							
	Fishwheel 1		Fishwheel 2		Fishwheel 5		Fishwheel 3				Fishwheel 4			
Date	Tags	Cum	Tags	Cum	Tags	Cum	Exam	Cum	Recap	Cum	Exam	Cum	Recap	Cum
20 Jul					0	22	3	707	0	62	3	2,418	0	251
21 Jul					0	22	0	707	0	62	2	2,420	0	251
22 Jul					0	22	0	707	0	62	0	2,420	0	251
23 Jul					0	22	1	708	0	62	3	2,423	1	252
24 Jul					0	22	1	709	0	62	5	2,428	1	253
25 Jul					0	22	1	710	0	62	0	2,428	0	253
26 Jul					0	22	2	712	0	62	0	2,428	0	253
27 Jul					0	22	0	712	0	62	1	2,429	0	253
28 Jul					0	22	0	712	0	62	0	2,429	0	253
29 Jul					0	22	0	712	0	62	1	2,430	0	253
30 Jul					0	22	0	712	0	62				
31 Jul					0	22	0	712	0	62				
1 Aug					0	22	0	712	0	62				
2 Aug					0	22	1	713	0	62				
3 Aug					0	22	1	714	0	62				
4 Aug							2	716	0	62				
5 Aug							0	716	0	62				
6 Aug							3	719	0	62				
7 Aug							1	720	0	62				
Total	1,243		2,114		22		720		62		2,430		253	

PHOTO PLATES

Photo 1. Johnny Goodlataw and his grandson Vincent Goodlataw (Tazlina, AK) were contracted to design and construct wooden fishwheel baskets for fishwheel 5 which was operated near Baird Canyon, and replacement baskets for fishwheel 4 which was operated at Canyon Creek, 2005.

Photo 2. Pontoon assemblies for fishwheels 1 and 2 that were stored over the winter at the Baird Canyon camp. This photo was taken on 6 May, the first day of mobilization in 2005.

Photo 3. Fishwheel 5 in operation along the west bank of the Copper River approximately 1.5 km upstream of Baird Canyon, 2005.

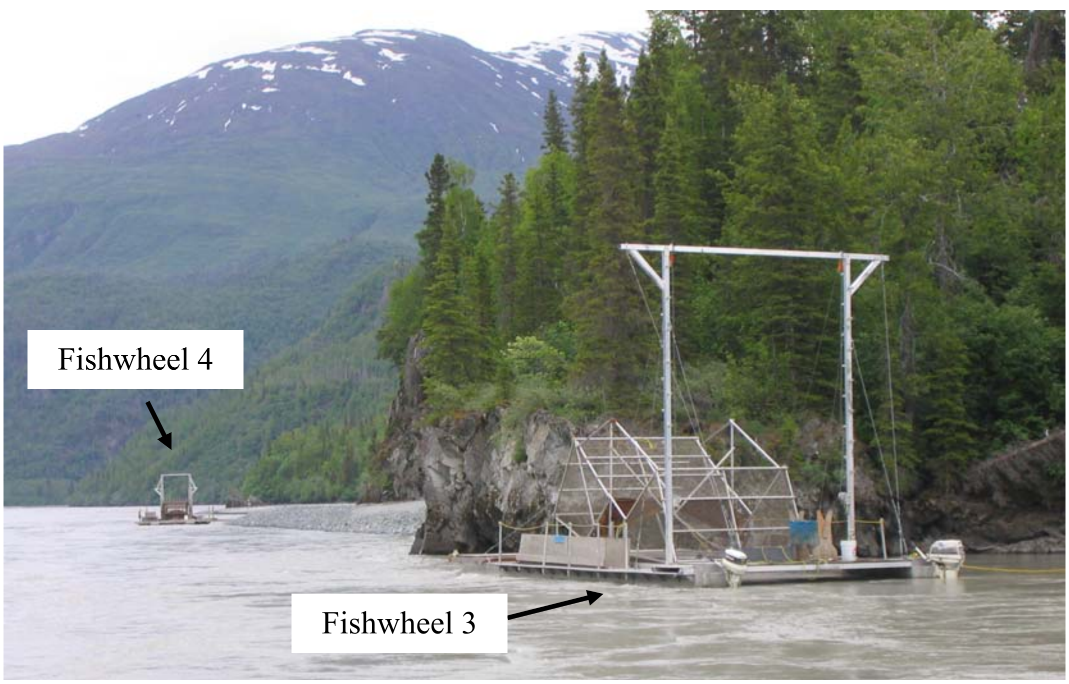

Photo 4. Fishwheels 3 and 4 in operation along the east bank of the Copper River downstream from the mouth of Canyon Creek, 2005.